PROGRESS IN SOIL AND WATER CONSERVATION RESEARCH

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USE OF THIS REPORT

This is not a publication and should not be referred to in literature citations. The report is distributed to U. S. Department of Agriculture personnel engaged in soil and water conservation and to directly cooperating professional agricultural workers who are in a position to analyze and interpret the preliminary results and tentative findings of experiments reported herein.

The Branch will publish the results of experiments reported here as promptly as possible. Some of the results carried in these quarterly reports are simultaneously in the process of publication.

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The Soil and Water Conservation Research Branch works in cooperation with the State Agricultural Experiment Stations.

M. L. DuMars, who assisted with the planning and establishment of these Quarterly Reports, has resigned as Liaison Officer between the Agricultural Research Service and the Soil Conservation Service to accept the position of Chief, Program Services Branch, Information Division, ARS. D. M. Whitt, formerly Research Liaison Respresentative for SCS-ARS in the Midwestern States with headquarters at Urbana, Ill., has been appointed to succeed Mr. DuMars. Prior to his work at Urbana, Dr. Whitt was engaged in soil and water conservation research in cooperation with the University of Missouri for 15 years.

CONTENTS

IRRIGATION

New Jersey

ROTATION AND IRRIGATION GIVE HIGHEST POTATO YIELDS

G. D. Brill and J. C. Campbell, New Brunswick.--Katahdin potatoes were grown on a Sassafras loam continuously, in a 2-year rotation with wheat and in a 3-year rotation with wheat and hay. One-half of each plot was irrigated with rotary sprinklers when the soil moisture tension at a depth of 8-inches reached approximately one atmosphere. One inch of water was applied each time to bring the soil back to field capacity. This averaged about once a week during dry periods at peak growth.

During the period 1947 through 1955 irrigation increased yields in 5 of the 9 years. In the other years, 1947, 1948, 1950, and 1951, rainfall was near normal and fairly well distributed. During these years potatoes were irrigated from one to four times with little effect on yields. Frequently the irrigation was followed by rain within 1 or 2 days. In the 5 years when prolonged dry periods occurred, potatoes were irrigated from four to nine times with substantial increases in yield. Summaries for these two periods are shown in the table below.

Potato yields as affected by irrigation, New Jersey, 1947-1955

Rainfall	Treatment	Yield of No. 1 potatoes per acre		
		Continuous potatoes	2-year rotation	3-year rotation
		Bushels	*Bushels*	*Bushels*
Adequate.........	Irrigated	260	294	290
	Not irrigated	254	284	302
Drought..........	Irrigated	269	350	344
	Not irrigated	159	191	213

Potatoes in a 2-year rotation with wheat gave the highest yields under irrigation. Without irrigation yields of potatoes in the 3-year rotation were slightly higher, but not enough to justify the extra year out of cultivation.

Soil physical measurements were made at harvesttime in the fall. Aggregate stability was highest and soil density lowest on the 3-year rotation, with the 2-year rotation nearly as good. In years of normal rainfall aggregate stability was lower and soil density higher on the irrigated plots. During the dry years irrigation did not appreciably affect aggregate stability or density.

Rotation also improved quality as measured by specific gravity and taste of the potatoes. Irrigation improved quality in the dry years but not in years of adequate rainfall.

North Carolina

DROUGHT DURATION UNAFFECTED BY SOIL PROPERTIES

C. H. M. van Bavel and L. A. Forrest, Raleigh.--Investigations, which were described in the August 1955 issue of the Quarterly Report, indicated that moisture-holding

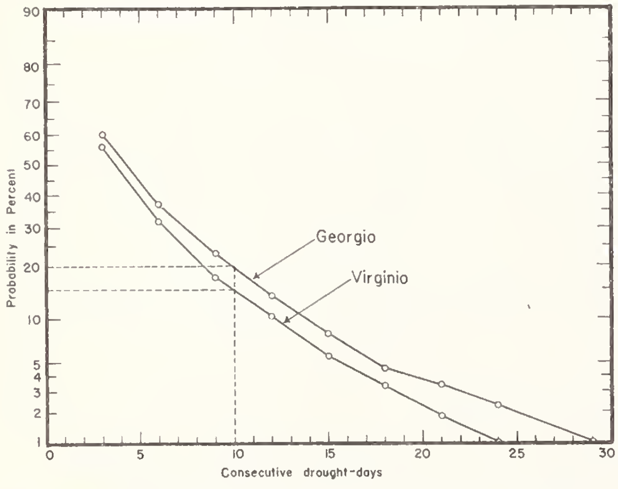
capacity of soil had a marked influence on drought frequencies. Further study shows that (1) soil physical properties have no influence on the duration of droughts in the Southeast; (2) droughts are more frequent on soils of low-moisture-storage capacity, such as sands, than on soils of high-storage capacity, such as clay loam; (3) once a drought period begins its duration is not affected by soil properties; and (4) a drought can be broken only by rain or irrigation.

The general procedure for making drought studies consists of counting the number of days on which a moisture deficiency was estimated to occur for 25 years of record. In the tabulating process, these drought-days are given sequential numbers. That is, the first day of the sequence is marked 1, the next one 2, and so forth. Further, the number of 1st, 2nd, 3rd, etc. drought-days in each season is computed.

Data for Farmville, Va., for 25 years of record and for two soil moisture storage capacities, 1 inch and 4 inches, are given in the accompanying table. By comparing data such as these for a station, it is apparent that the distribution of drought-day sequences is practically the same, regardless of the soil storage capacity. This means that, once a period of drought has set in, its duration is not affected by the capability of the rootzone to store moisture. When soil-storage capacity for water is low, droughts are more frequent. But, once a drought period begins, its duration is not longer determined by soil properties.

Number of drought-day sequences of differing length and percentage of total number at Farmville, Va.

Length of sequence	Soil moisture storage capacity 1 inch		Soil moisture storage 4 inches	
	Occurrence		Occurrence	
Days	*Number*	*Percent*	*Number*	*Percent*
1 - 3...........	133	47.2	23	39.0
4 - 6...........	75	26.6	15	25.4
7 - 9...........	31	11.0	8	13.6
10 - 12...........	16	5.6	6	10.1
13 - 15...........	12	4.3	3	5.1
16 - 18...........	6	2.1	1	1.7
19 - 21...........	6	2.1	1	1.7
22 - 24...........	0	0.0	1	1.7
25 - 29...........	2	0.7	1	1.7
30 - 34...........	1	0.4	0	0.0
Total..........	282	100.0	59	100.0



Probability of consecutive drought-days in Georgia and Virginia.

Little difference was found in the distribution of drought sequences between stations or major areas investigated. This is illustrated in the accompanying figure. It is evident that the chances for drought periods to be shorter than, for example, 3 days are not very high, about 40 percent. On the other hand, droughts longer than 20 days are rare.

These observations emphasize the importance of irrigating as soon as is needed. When the soil has lost its available moisture, irrigation should be applied immediately, because the chance of the drought to be broken in the next few days by rain is very low.

Florida

TENSIOMETERS GUIDE IRRIGATION OF VEGETABLES AND FIELD CROPS

Dalton S. Harrison and J. C. Stephens, Ft. Lauderdale.--Water control is a problem for crop growers on the lower east coast. Low-lift pumps serve well in getting the water for subsurface irrigation to the fields. The problem is knowing how much water to hold for maximum crop growth and production.

In the last 2 years a number of soil-moisture measuring devices have been studied in tanks with controlled water tables at the Plantation Field Laboratory. Of these, the mercury manometer-type tensiometer appears to have value in indicating water table depths on fine sandy soils. Other workers have used them on many other soil types and indicate that the mercury manometer-type tensiometers show great promise in timing for irrigation.

Tensiometers installed in tanks with controlled water table depths of 12, 18, 24, 30, and 36 inches gave distinct readings, within a certain range, corresponding to measured water table depth. On a fine sandy soil in which optimum crop growth and production were found at the 2-foot water table, tensiometers gave readings from 45 to 60. When the water table was raised to 1 foot below the surface, the tension dropped to 20. In subsequent tests where the water table was lowered to 3 feet, the tension readings were in the 500-600 range.

On sandy soils, where the required water table does not cause a tension beyond the range (850 cm.) of the tensiometer, this instrument can be an invaluable aid as an indicator of water tables.

The following tables give pertinent data on yield and maximum daily water consumption of corn grown in 1/1,000 acre lysimeters. These data indicate the necessity for accurate soil-moisture-measuring devices.

TABLE 1.--Yield and maximum daily water consumption of corn grown at different water table depths, Ft. Lauderdale, Fla., 1955-56*

Water table depth	Tank number	Lysimeter yield		Yield per acre		Maximum daily water use
		Green forage	Dry grain	Green forage	Dry grain	
Inches		*Pounds*	*Pounds*	*Pounds*	*Bushels*	*Inches*
12	4	35.1	5.5			.16
12	7	49.5	7.1			.23
12	11	40.0	6.2			.22
Average		41.5	6.3	41,500	88.2	.20
24	1	39.7	5.7			.13
24	6	45.8	7.7			.17
24	12	42.8	6.2			.18
Average		42.8	6.5	42,800	91.0	.16
36	2	24.8	3.5			.11
36	5	31.9	5.1			.08
36	10	36.2	5.8			.11
Average		31.0	4.8	31,000	68.6	.10
Variable	3	29.7	4.5			---
Do	8	44.0	6.2			---
Do	9	43.7	6.9			---
Average		39.1	5.9	39,100	82.6	---

*Corneli 54 corn planted September 30, 1955, harvested January 17, 1956.

From the above data it appears that a water table of about 24 inches is best suited for both grain and forage yield of Corneli 54 corn. An unusually cold spell of 2 weeks' duration with several days of sub-freezing temperatures materially affected the yields of this particular crop.

TABLE 2.--Yield and maximum daily water consumption of corn grown at different water table depths, Ft. Lauderdale, Fla., 1956*

Water table depth	Tank number	Lysimeter yield		Yield per acre		Maximum daily water use
		Green forage	Dry grain	Green forage	Dry grain	
Inches		*Pounds*	*Pounds*	*Pounds*	*Bushels*	*Inches*
18	1	51.5	8.1			.32
18	2	39.4	7.1			.27
18	7	49.7	6.5			.33
18	8	41.7	7.2			.32
Average		45.6	7.2	45,600	101.15	.31
24	3	49.2	7.6			.27
24	4	35.7	6.1			.19
24	9	53.7	7.5			.28
24	10	47.4	8.0			.29
Average		46.5	7.3	46,500	102.20	.26
30	5	43.3	6.4			.21
30	6	35.4	6.2			.19
30	11	37.0	5.6			.21
30	12	43.5	5.5			.23
Average		39.8	5.9	39,800	82.95	.21

*Corneli 54 corn planted February 2, 1956, harvested June 1, 1956.

From the above data it appears that a water table between 18 - 24 inches is suitable for both grain and forage yield of Corneli 54 corn. This corn was grown in an exceptionally dry season--a fact which might favor the higher water tables. Field practice might favor somewhat higher water levels early in the growth of the corn plant with a slight lowering of the table as the root system develops.

Missouri

HIGH YIELDS REQUIRE ADEQUATE WATER

D. D. Smith and V. C. Jamison, Columbia.--The need for supplemental water for full-crop production on highly fertilized midwest claypan soils in years of normal rainfall is illustrated by evapo-transpiration measurements made in 1955 for a 9-acre field of corn at McCredie. Evapo-transpiration and supply balanced quite well for the first 6 months of the year. But in July evapo-transpiration was 9.16 inches, or 6.30 inches more than the supply, which was only 0.60 inches below normal. The difference was made up in part by depletion of the soil moisture reserve but it was not enough to produce a full crop. The available moisture capacity of the upper 3 feet of soil on this field is 5.57 inches and for the fourth foot it is 1.88 inches. The corn averaged 43 bushels per acre for the field, in contrast to 154 bushels per acre for irrigated corn on a nearby field. Temperatures for 1955 were very near normal and the July-August rainfall was only 1.41 inches below normal. These data are shown below.

Water balance by months for a 9-acre field of Mexico silt loam cropped to corn, McCredie, Mo., 1955

Month	Temperature		Precipitation		Precipitation minus runoff	Evapo-transpiration	Deficit or excess	
	Normal	1955	Normal	1955			Per month	Accumulative
	°F	°F	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Jan.	30	32	2.08	1.97	1.11	.80	+.31	+.31
Feb.	33	34	1.76	3.01	2.02	1.12	+.90	+1.21
March......	44	44	2.96	1.24	.84	1.47	-.63	+.58
April......	55	61	3.79	2.95	2.45	3.65	-1.20	-.62
May........	65	65	4.77	3.01	2.84	2.68	+.16	-.46
June.......	73	68	4.81	4.83	4.34	3.45	+.89	+.43
July.......	78	80	3.47	2.87	2.86	9.16	-6.30	-5.87
Aug.	76	77	3.56	2.75	2.75	2.93	-.18	-6.05
Sept.	69	66	4.25	3.93	3.93	2.30	+1.63	-4.42
Oct.	57	57	3.10	4.44	4.06	1.04	+3.02	-1.40
Nov.	44	40	2.46	.63	.63	.41	+.22	-1.18
Dec.	34	32	2.00	.17	.17	.18	-.01	-1.19
Average..	55	55	39.01	31.80	28.00	29.19	-1.19	

Missouri

PRECIPITATION MINUS RUNOFF MEASURES EVAPO-TRANSPIRATION

D. D. Smith and V. C. Jamison, Columbia.--Precipitation minus runoff as an average over a period of years is a good measure of evapo-transpiration under certain soil and climatic conditions. On a claypan soil where percolation to ground water is insignificant and where moisture recharge is practically completed by the end of December, average annual precipitation minus surface runoff is essentially equal to average annual evapo-transpiration. On well-fertilized claypan soils of central Missouri this amount averaged 31 inches for the 10-year period 1941-50 for cropping systems that provided a living cover throughout most of the year. Average monthly and annual precipitation for the 10-year period were very close to the 60-year average. Data for 6 rotations are shown in Table 1.

TABLE 1.--Average annual runoff and precipitation minus runoff for six rotations on Mexico silt loam, McCredie, Mo., 1941-50

Rotation	Annual runoff	Precipitation minus runoff
	Inches	*Inches*
Corn-oats, no soil treatment..........................	11.74	27.44
Corn-corn-oats-wheat (Sweetclover)....................	8.83	30.34
Corn-wheat-meadow.....................................	8.42	30.75
Corn-wheat-meadow-meadow..............................	8.39	30.70
Soybeans-small grain-meadow...........................	7.96	31.21
Corn-wheat-sweetclover hay............................	7.89	31.28

The small variation in precipitation minus runoff shown for the last 4 rotations of Table 1 indicate that evapo-transpiration is constant where plant cover is essentially continuous and abundant. For these rotations the maximum deviation from the mean of 31.01 inches was less than 1 percent. For the second rotation, corn-corn-oats-wheat and sweetclover, evapo-transpiration was slightly lower but this system did not provide a living cover over one-half of the winters. For the first rotation, corn-oats, a living cover existed less than one-third of the total time, including the growing season. Average monthly precipitation minus runoff for two of the above rotations is shown in Table 2.

TABLE 2.--Average monthly precipitation and runoff for two cropping systems on Mexico silt loam, McCredie, Mo., 1941-50

Month	Precipitation		Runoff		Precipitation minus runoff	
	60-year average	1941-50 average	C-O[1]	C-W-Cl.	C-O[1]	C-W-Cl.
	Inches	*Inches*	*Percent*	*Percent*	*Inches*	*Inches*
January	2.08	1.72	36	28	1.10	1.24
February	1.76	1.50	46	31	.81	1.03
March	2.96	3.03	47	37	1.62	1.92
April	3.79	3.87	32	32	2.62	2.63
May	4.77	4.63	32	17	3.14	3.83
June	4.81	5.36	33	19	3.57	4.36
July	3.47	3.25	22	10	2.53	2.94
August	3.56	3.30	9	1	3.01	3.27
September	4.25	4.29	21	11	3.37	3.83
October	3.10	4.41	33	27	2.97	3.22
November	2.46	2.19	27	15	1.59	1.87
December	2.00	1.62	31	30	1.11	1.14
	39.01	39.17	30	20	27.44	31.28

[1] This rotation did not receive soil amendments; C-W-Cl rotation received lime and starter on wheat the first 6 years and full treatments for corn and wheat the last 4 years.

The annual cycle of soil-moisture depletion and recharge typical of the midwest claypan soils is shown by monthly runoff. The same trend is shown for both rotations in Table 2, although runoff for the non-fertilized rotation of corn-oats was nearly 50 percent greater than for the rotation allowing least runoff. Runoff during August for the rotation on fertilized soil approached zero as water demands of the lush-growing crops depleted the soil moisture reserve. As evapo-transpiration decreased during the fall and recharge of soil moisture took place, the runoff increased. The recharge was completed by February and March when runoff reached a maximum.

Idaho

INFILTRATION INCREASED BY MIXING SEBREE SOIL

Claude H. Pair, Boise.--The irrigation of large areas in southwestern Idaho and eastern Oregon is made difficult by the widely varying infiltration rates between Chilcott and Sebree soils. Ring infiltration rates of 0.12 to 0.43 inches per hour are obtained on the Chilcott series while rates of 0.00 to 0.06 inches per hour are obtained on the Sebree series.

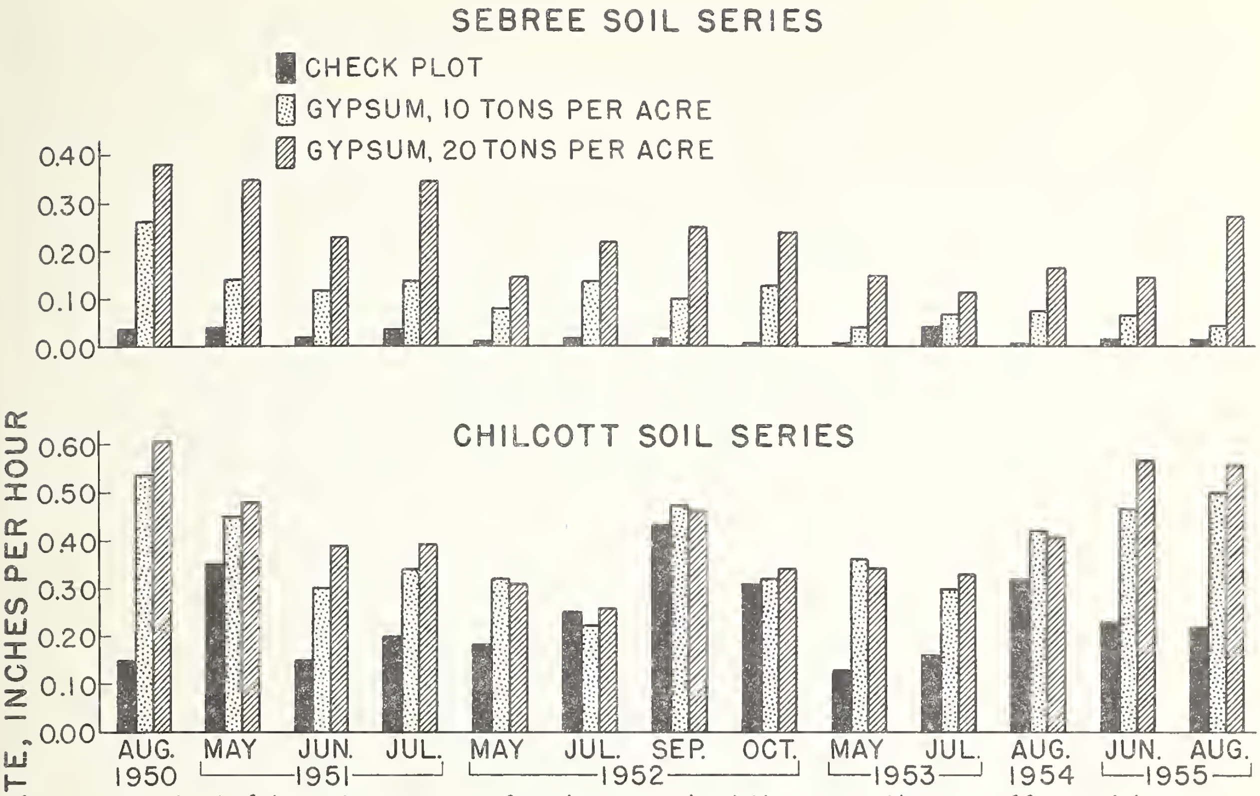


Fig. 1.- Infiltration rates of Sebree and Chilcott soils, as affected by gypsum treatments, Idaho, 1950-1955.

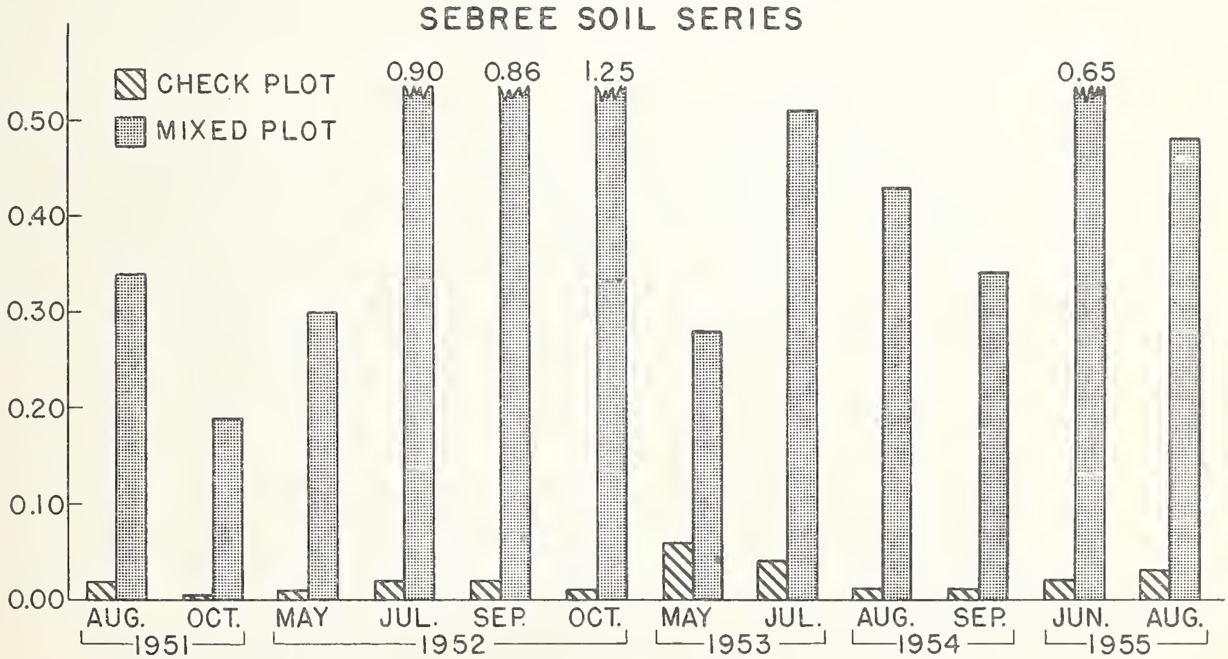


Fig. 2.- Infiltration rates of Sebree soil as affected by mixing treatment Idaho, 1951-1955.

The Sebree soil series comprises solodized-solonetz soils having a pygmy or telescoped profile. The very thin "A" horizon is neutral or nearly neutral in reaction. The subsoil is saline, contains gypsum, and is affected by the presence of exchangeable sodium. It is not strongly alkaline.

Irrigation waters enters the Sebree soil very slowly so that continuous irrigation is needed during the hottest part of the season to meet crop requirements. This soil series is found as spots, usually 5 to 60 feet in diameter within the Chilcott series. The Sebree soils comprise from 5 to 50 percent of the land surface in many fields. Efficient use of irrigation water cannot be obtained in fields having interspersed areas of these two soils.

Two methods for improving the infiltration rate of the Sebree soil have resulted from research conducted since 1950. One is the application of gypsum to the affected area and the other is the physical mixing of the soil profile to a depth of 48 inches. Ring infiltrometers were used to evaluate the results. Figure 1 shows the results of the addition of gypsum at the rate of 10 and 20 tons per acre on the Sebree and Chilcott soil series. Figure 2 shows infiltration rates obtained from physical mixing of the same soil profile of Sebree soil. Best results for increasing the infiltration rate from 0. 00 to above 0. 50 inches per hour on the Sebree soil series were obtained from the physical mixing treatment.

California

TESTS FOR SALINITY AND SODIUM STATUS OF SOIL AND WATER

L. A. Richards and C. A. Bower, Riverside. --Wherever irrigation is practiced, the accumulation of excess soluble salts is an ever-present hazard for the production of crops. This is true particularly in the arid regions where the water consumptively used by crops exceeds that provided by rainfall. Even in humid regions, where supplemental irrigation is now being extensively practiced, salinity sometimes causes damage if saline waters are used for irrigation. An interesting and important additional case is that of plants grown in greenhouses and inside homes where the soil is protected from normal precipitation. The plants are thus dependent upon irrigation and are subject to all the salinity hazards of an arid climate.

The physical condition of most soils can be unfavorable for the growth of crops if there is an excessive proportion of sodium ions on the exchange complex. Excessive exchangeable sodium is closely related to salinity, and both are usually associated with the quality of the irrigation water. For this reason, it is logical to consider the salinity and sodium status of soils and irrigation water together.

A rather extensive review of the practical information available on the diagnosis and improvement of soils affected by excess soluble salts and excess exchangeable sodium has been collected and presented in U. S. Department of Agriculture Handbook No. 60. This 160-page book is a useful reference for soil scientists and professional agricultural workers, but it contains so much material that fieldmen, horticulturists, and farmers, who are conserned with immediate production problems will not often take the time to get out of it the information they might profitably use.

To aid a wider circle of users, the U. S. Salinity Laboratory, Riverside, Calif., has prepared a simplified set of test procedures and apparatus for determining the salinity and sodium status of soil and irrigation waters. These tests are described in U. S. Department of Agriculture Circular No. 982, Tests for Salinity and Sodium Status of Soil and Irrigation Water. The equipment for making the tests is now commercially available.

The soil tests are based on solution extracted from a saturated soil paste. This solution is readily obtained with a portable vacuum filter. An electrical conductivity reading made on the saturation extract provides a practical index for appraising the effect of salinity on crops in any soil. A scale for the interpretation of this index is given in Circular 982.

The exchangeable sodium status of soil is estimated from the proportion of sodium to other cations in the saturation extract. This estimate is based on the fact that a fairly close relation exists between the electrical conductivity and the total cation concentration of soil extracts. The amount of calcium and magnesium in the saturation extract is determined by a titration with versenate (EDTA). This titration is made with a hand-buret in the portable test set.

The sodium concentration in the saturation extract, for most soils, can be taken as being approximately equal to the total cation concentration minus the concentration of calcium and magnesium. Graphs supplied in the circular make it possible to estimate the exchangeable sodium status of the soil directly from the conductivity reading and the versenate titration of the saturation extract.

A test is provided for estimating the amount of soluble-calcium amendment required to treat soils that are high in exchangeable sodium. For this purpose, a sample of soil is treated with gypsum solution and the amount of calcium, which reacts with the soil, is determined. Again, graphs and tables supplied in the circular give the interpretation and application of the test results.

In judging the quality of waters for irrigation, primary consideration is ordinarily given to the salinity and sodium hazards involved. The electrical conductivity of water is a good index of the salinity hazard, while the sodium hazard is largely determined by the proportion of the sodium to calcium plus magnesium present, together with the total salt content as indicated by electrical conductivity. The procedures and equipment for these tests are substantially the same as those for the saturation extract. A chart giving the sodium and salinity classification of irrigation waters in terms of electrical conductivity reading and the versenate titration are given in the circular.

There will, of course, be special cases not adequately covered by these simplified tests. However, with comparatively little training, most persons can quickly learn to make these salinity and sodium tests and apply the results to management operations under field and greenhouse conditions.

California

GROUND WATER STUDY STARTED IN EXCELSIOR AREA

Leonard Schiff, Bakersfield. --Ground water tables are declining in the Excelsior area because of excessive pumping. An exploratory investigation has been started in the Excelsior Soil Conservation District and the Kings County Water Storage District to study recharge. Water is being distributed in canals and sloughs of the area in an attempt to recharge the declining ground water basin. Soil borings will be made and experimental wells and piezometers will be installed to determine the extent of ground water movement from points of surface distribution.

California

AQUIFER RECHARGE THROUGH PIT AND TRENCH CONTINUES PROMISING

Leonard Schiff, Bakersfield. --The average infiltration rate of the infiltration pit at Minter Field was 1.2 acre feet per day for a period of 82 days excluding the interruption for cleaning. For the first 16 days of the test the average was 1.98 acre feet per day.

The pit exposed 1/29 acre of aquifer material covered with an average of 8 feet of water during the test period.

Cleaning the aquifer surface of accumulated silt was accomplished by first moving the pea gravel covering to the center of the pit and removing the surface 1/4-inch of sand with

flat-nosed shovels. After cleaning, the infiltration rate increased from 1.12 to 1.76 acre feet per day. Suction cleaning with a 2-inch pump and swimming pool type cleaner was not successful.

In another installation at Minter Field, an infiltration trench exposed about 0.2 acre of "average aquifer" with a water surface of 0.5 acre when operated with a head of about 7 feet of water. Infiltration rates averaged 2.5 acre feet per day for the first 30 days of the test period and 2.2 acre feet per day for the total run of 61 days.

Again, attempts to clean the aquifer surface with suction equipment were not successful. The infiltration rate was 0.67 acre feet per day on the final day of the 61-day test period. After cleaning, this rate improved to 1 acre foot per day and then declined in a few days to a rate of 0.63 acre feet per day. This temporary recovery may have been due partially to the disturbance of the settled material by the action of the suction cleaner itself and to some removal of the settled material. The suction pump used was inadequate in capacity. The trench was later dried and cleaned by scraping with power equipment.

California

GROUND WATER RECHARGE AFFECTED BY WATER SOURCE

Eldred S. Bliss, Bakersfield.--Performance tests on gravel-filled injection shafts (Pond 26) reported in the August 1955 Quarterly Report, page 6, have been continued. Results of two shafts run simultaneously for a period of 8 months showed a maximum injection rate 0.85 acre foot per day with well water. After 7 1/2 months, this rate dropped to 0.4 acre foot per day. When Lerdo canal water was substituted for well water, injection rates declined to about 0.15 acre foot per day in a period of 2 weeks. Similar results were obtained on a second run started in March 1956. The problem of redeveloping shafts and providing efficient filters to handle sedimented canal water appears to be of major importance for success of this method of ground water recharge. Temperature change, short interruptions of water supply, differences in water quality, and microbial activity are other complicating factors being currently investigated.

DRAINAGE

New York

WORK BEGINS ON LOW-COST SUBSURFACE DRAINAGE STUDY

C. D. Busch, Ithaca.--Research has been started to develop a more efficient and economical subsurface drainage method; one that requires less earth movement and handling of material. The approach to the problem is the improvement of the lowest cost subsurface drainage system, mole drains, to provide more satisfactory results under a wide range of soil and topographic conditions.

The program will move ahead concurrently on three phases:

1. Field and field-laboratory investigations to determine the causes of mole drainage failure and to test methods of increasing the life and performance of these drains.

2. A laboratory study of potential lining materials with emphasis on structural and hydraulic design.

3. Development of machinery capable of installing liners and fill materials.

Following these initial phases of the work, the most promising methods and materials will be studied in field installations under a range of conditions.

Washington

EROSION AND RUNOFF CONTROLLED BY CLODDINESS AND MULCH COVER

Loy M. Naffziger and Glenn M. Horner, Pullman.--Runoff and soil loss measurements during the 1955-56 winter season showed that tillage operations that produce cloddiness or a mulch cover effectively control erosion on sweetclover land seeded to winter wheat.

Some of the cropping systems in the higher rainfall sections of the Pacific Northwest wheat-belt include sweetclover grown as a green manure crop or for pasture. A common practice is to turn under the clover with a moldboard plow in early June when the top growth is 2 to 3 feet high. The land is summer-fallowed but cultivated several times during the summer to control weeds. These operations result in excessive pulverization of the soil and are largely responsible for the heavy erosion losses on much of the sweetclover green manure land.

Pastured sweetclover is usually plowed in late July or August when the soil is dry enough to form clods and to prevent weed growth. Observations show that erosion losses are low when this land is seeded to winter wheat with a minimum of seedbed preparation. Previous work has shown, also, that erosion is greatly reduced by the utilization of sweetclover as a mulch.

Erosion measurements were made to determine the effect of the following three tillage treatments applied to sweetclover land:

1. Early plowing: Land was moldboard plowed in early June when considerable moisture remained in the soil. The land was harrowed immediately and cultivated six times during the summer.

2. Late plowing: The sweetclover top growth was cut in early June with a "stubble buster." Regrowth on the clover was 30 to 36 inches and in bloom when the land was moldboard plowed July 15. No other tillage operation was performed prior to seeding winter wheat.

3. Mulch tillage: The sweetclover top growth was cut in early June with a "stubble buster" and the regrowth plowed August 2 with a subsurface tiller (sweep). These operations were repeated in October prior to seeding winter wheat.

Average erosion losses from three replicates during the 1955-56 winter season as affected by these treatments are as follows:

Tillage treatment	Runoff	Soil loss per acre
	Inches	*Tons*
Early plowing	3.58	3.1
Late plowing	0.25	0.1
Mulch tillage	0.32	0.1

The following conclusions can be drawn:

These data confirm observations that tillage is the dominant factor affecting erosion on sweetclover land.

Soil pulverization resulting from early plowing plus weed control cultivation caused relatively high erosion losses.

Plowing at low soil-moisture content, cloddiness and mulch cover, effectively controlled erosion.

There was no significant difference in the effect of the late-plowed and mulch treatments.

Washington

SOIL PROTECTION REQUIRED AGAINST WIND EROSION DURING WINTER

Stephen J. Mech, Prosser. --Winter is a period of great wind erosion hazard in the Columbia Basin irrigation project. Cessation of vegetative growth, sandy soil, low precipitation, and strong winds combine to produce serious erosion damage on unprotected land. These are conclusions reached at the end observations of two winters at the Wind Erosion Control Demonstration Farm near Eltopia, Wash.

Protection by resistant vegetation, crop residue, or ridging, is almost a necessity during the non-growing season. Vegetative residues, such as cornstalks, aftermath of pasture or alfalfa, or wheat stubble, are usually adequate by themselves and no additional protection is required.

Fields that do not have such crop residues should be seeded to a cover crop of winter grain. A winter cover crop will "heal-over" many incipient blow spots before they cause much trouble. The cover crop should be seeded early enough to insure adequate growth before freezing weather. The crop should also be winter hardy, because lush, immature vegetation leaves very little residue after freezing.

Winter cover crops of oats, vetch, winter wheat, and sweet clover seeded on September 5 were tested on newly leveled Othello fine sandy soil. A summary of performance follows:

1. Only wheat provided adequate cover throughout the non-growing season.

2. Sweet clover and vetch failed to make enough growth to provide any protection. The little growth produced was killed back to the crown and it was not until mid-spring that any appreciable regrowth occurred.

3. Oats made the best early growth. By the middle of October they were 6 to 8 inches high but they were killed by freezing weather as expected. This lush growth, however, provided practically no residue and thus no soil protection during the winter and early spring.

4. Alfalfa, seeded on September 5, failed to withstand the winter winds. Although the stand was adequate early in the season, the plants were too small and tender to survive the repeated blowing during the winter months. It did not have the ability to "heal over." On the other hand, alfalfa protected by wheat stubble came through the winter in excellent condition.

5. Wheat straw anchored sufficiently to keep it in place provided adequate protection to the surface soil. Straw is not practical for use on large acreages but it is excellent for control of soil blowing on small areas. The volunteer growth of wheat is objectionable in the low-growing row crops that follow.

Where winter cover crop seeding cannot be made, considerable protection can be provided by making the surface as rough as possible. Ridging is recommended. Though the roughness deteriorates with exposure to the elements, the combination of moisture,

residual roughness, and consolidation, tends to provide a measure of protection though it does not equal that provided by cover crops or crop residues.

Considerable wind erosion damage can be avoided by simply staying out of the field during the winter months. Pulverization of the soil in tractor and implement tracks is often the beginning of "blow spots." To reduce this danger, tractor and implement travel over bare fields should be reduced to a minimum during the non-growing season. Bare ground will not "heal-over" until growing weather comes.

Colorado

STUDY STARTED ON EFFECT OF SOIL REMOVAL ON WINTER WHEAT PRODUCTION

B. W. Greb, Akron.--Mass removal of soil by damaging windstorms in parts of the Central Great Plains during the 1930's and again since 1950 has caused some speculation as to the ultimate future productivity of these soils. This is particularly true of the heavier textured wheatlands where soil removal in extreme cases has extended to the subsoil lime zone. An experiment has been initiated at the Akron Station simulating soil removal to variable depths to determine its effect on winter wheat production and to determine if such damaged soil could be improved by residue management and/or addition of commercial fertilizers.

In November 1955 soil removal operations were completed on a virgin Weld silt loam blue grama--buffalo grass sod with an 0.84 percent uniform slope. The Soil Conservation Service designates the soil as We 3231. By cross-slope leveling, a progressively deeper cut was obtained from 0 inches on the downslope side to 15 inches on the upslope side in a 150-foot width. The total 150-foot width was divided into 0-3, 3-6, 6-9, 9-12, and 12-15 inch cut increments of 30 feet each. Two replications were treated identically for each soil removal depth.

The main soil removal treatments were subdivided for alternate fallow and wheat sequence. These were again subdivided in such a manner that two different methods of summer fallow will be utilized, residue vs. no residue management. Superimposed upon these tillage treatments are three fertilizer treatments of no fertilizer, nitrogen, and nitrogen plus phosphorus.

The subsoil lime zone was exposed at the 11-inch depth on one replication and at 12.5 inches on the other replication.

Waterways and small terraces have been constructed to prevent runoff water from moving from one soil removal plot to another.

Nebraska

CROP RESIDUES REDUCE RUNOFF AND EROSION MORE THAN HPAN

F. L. Duley, Lincoln.--A summary of work of three seasons showed that Krilium (HPAN) reduced runoff and erosion when compared with untreated land. However, crop residues covering the soil were more effective than any of the HPAN treatments. A summary of the results obtained is shown in the following tables:

Runoff as affected by HPAN and straw treatments, Nebraska, 1952-54

Year	Rainfall*	Runoff				
		Treatment (pounds per acre)				
		HPAN				Straw
		None	1,000	2,000	4,000	5,000
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1952.......	14.66	4.87	4.20	3.07	2.88	0.39
1953.......	5.72	1.39	1.21	0.61	0.20	0.30
1954.......	22.44	9.02	7.11	6.26	4.89	1.04
Total......	42.82	15.28	12.52	9.94	7.97	1.73

*Total for rains during which runoff occurred on one or more plots.

Soil loss as affected by HPAN and straw treatments, Nebraska, 1952-54

Year	Rainfall*	Soil loss per acre				
		Treatment (pounds per acre)				
		HPAN				Straw
		None	1,000	2,000	4,000	5,000
	Inches	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1952.......	14.66	22.16	11.07	2.31	2.35	0.09
1953.......	5.72	7.42	5.64	1.89	0.51	0.54
1954.......	22.44	57.26	34.49	21.61	13.65	0.61
Total......	42.82	86.84	51.20	25.81	16.51	1.24

*Total for rains during which runoff occurred on one or more plots.

Tests showed that the HPAN treatments greatly increased the percent of large-sized aggregates. This probably accounted for the increased absorption compared with the untreated plot, but the effect was not sufficient to equal the effect of the straw mulch.

Nebraska

STUDY STARTED ON DESIGN CRITERIA FOR VEGETATED WATERWAYS

Norris P. Swanson, Lincoln.--Only limited data and field experience are now available for the design of vegetated waterways to provide for the disposal of irrigation waste water as well as runoff from precipitation on fields with slopes of 1 to 4 percent. This is a pressing problem in Nebraska. Installation of two experimental waterways near Red Cloud, in south central Nebraska, should provide some answers to this problem.

The objective of this investigation is to evaluate the effectiveness of recommended grasses for protection of a waterway of standard design under peak flow conditions following prolonged and intermittent flows of irrigation waste water. One waterway has been

seeded to a recommended grass mixture. On the other, six adapted grass mixtures have been seeded on replicated sections.

The waterways have been constructed with a 3 percent slope on the upper end and a 6 percent slope on the lower end. A range of velocities for a given flow of water has been made possible by progressively decreasing the width of each section from the upper to lower end. Peak flows will be simulated by use of large streams of irrigation water delivered from a main canal near the upper end of the waterways. Waste water will be discharged into a large farm pond at the lower end of the waterways.

Wisconsin

GRASS STRIP BETWEEN CORN ROWS REDUCES SOIL LOSS

Orville E. Hays, LaCrosse.--In 1954 an experiment was started on a 16 percent, east-facing slope to determine the effect of grass strips between corn rows on corn yield and on soil and water losses. Results indicated that nearly perfect erosion control was accomplished by this practice. The experiment was expanded in 1955 to determine water utilization by corn under the following treatments: (1) standard, with the entire plot plowed; (2) a 20-inch band of dead mulch between rows, herbicides used to kill the vegetation; (3) a 20-inch band of grass between corn rows, clipped to maintain growth height at less than 6 inches; (4) a 20-inch band of grass, not mowed.

Soil moisture samples were taken prior to planting corn, corn at 3-inches height, corn at 12-inches height, corn at 40-inches height, first tassel, roasting ear, full dent, and maturity. Soil samples were taken to a 5-foot depth in the row, 10 inches above the row, 10 inches below the row, and midway between rows. Each plot was equipped for runoff measurement.

Results from the 1955 Experiment are given in the following table.

Effect of grass strip and mulch on runoff, soil loss, evapo-transposition, and yield of corn, LaCrosse, Wis., 1955

Treatment	Runoff	Soil loss per acre	Evapo-transposition	Corn yield per acre
	Inches	*Tons*	*Inches*	*Bushels*
Standard (plowed).........	0.39	3.61	17.51	57.7
Dead mulch band...........	0.23	0.83	18.31	55.4
Grass band, clipped.......	0.06	0.04	18.40	54.3
Grass band, not clipped...	0.02	0.01	18.13	49.5

It is of interest to note that the water use was very similar by the plots with dead mulch and the clipped grass. Corn yields were influenced by the treatments, but not so much as to be expected during a hot, dry year such as in 1955.

Soil and water loss measurements show the advantage of the bands of grass. The clipped band and the unmowed treatment gave nearly perfect control, but the yield was reduced 3 to 8 bushels. Data for additional years should determine if these treatments are economically feasible.

Georgia

GRASS REDUCES SOIL AND WATER LOSSES

G. N. Sparrow and R. L. Carter, Tifton. --Average annual soil and water losses from 1951 through 1955 on a 3-percent slope of Tifton loamy sand at Tifton are given below:

Average annual soil and water losses, Tifton, 1951-1955

Cropping	Water loss		Soil loss per acre
	Inches	*Percent*	*Tons*
Coastal Bermudagrass (Crimson clover)........................	0.19	0.47	0.22
Spanish peanuts grown annually......	2.65	6.51	1.37
Three-year rotation of peanuts (lupines), hybrid corn, and oats Crotalaria or (blue lupine).......	1.78	4.37	1.35
Pensacola Bahiagrass 2 years, hybrid corn, Spanish peanuts......	0.98	2.41	0.70

These preliminary data are the basis for the following observations:

1. The average annual water losses from peanut land, where peanuts are grown in annual sequence, will probably exceed 6.5 percent of the rainfall. Under a perennial sod of Coastal Bermudagrass the annual loss may be as low as 0.5 percent. A grass-based rotation, with the grass base of 2 years' duration and with row crops for 2 years, will modify losses to about 2.5 percent of the rainfall.

2. A 3-year rotation of Spanish peanuts, corn, and oats has little practical advantage over peanuts grown annually in the control of soil and water losses. The rotation involves plowing the land for fall and winter crops.

3. A grass-based system of cropping, with grass remaining for at least 2 years, has the characteristics of an excellent soil-conserving system. The most favorable year in a grass-based rotation is that of the second year of grass, or the year when grass is well established. Less favorable even than row crop years is the year of grass establishment. Consequently, it appears that, although a grass-based system of cropping with 2 years of grass has favorable aspects, the ultimate advantage will be largely determined by the length of the period grass occupies the land.

4. The most hazardous periods for soil and water losses in the middle Coastal Plain of Georgia, in the order of their severity, are March-April, December-January, and June-July.

SOIL FERTILITY

New York

WOOD CHIPS ENCOURAGE EARTHWORM ACTIVITY

George R. Free, Ithaca.--Marked increases in earthworm population have been associated with the use of fresh wood chips as a soil amendment in an experiment started in 1951 on Honeoye silt loam. This soil is well-drained and derived from glacial till high in limestone. The pH of the plow layer is at, or slightly above, 7.0 without liming.

Early in 1955 test pieces of maple wood, 1/4 x 2 x 12 inches in size and weighing about 65 grams, were driven into plots of the experiment and left until the spring of 1956 when they were removed and the loss in weight determined. At this time, counts were made to determine the relative population of earthworms on each plot.

The number of earthworms under two levels of fertilizer with and without wood chips and with three systems of soil management are given below. Along with this information are the data showing the loss in weight of maple sticks taken from the plots.

Soil management	Without wood chips				With wood chips			
	Fertilizer level				Fertilizer level			
	High[1]		Low		High[1]		Low	
	Earth-worms[2]	Loss in weight of sticks	Earth-worms[2]	Loss in weight of sticks	Earth worms[2]	Loss in weight of sticks	Earth worms[2]	Loss in weight of sticks
	Number	*Grams*	*Number*	*Grams*	*Number*	*Grams*	*Number*	*Grams*
No sod or cover crop in rotation...........	12	8	8	6	38	10	32	8
Cover crop but no sod crop....	14	6	13	5	38	10	38	8
Cover crop and 1 or 2 years of sod crop.......	15	6	15	7	41	17	37	11

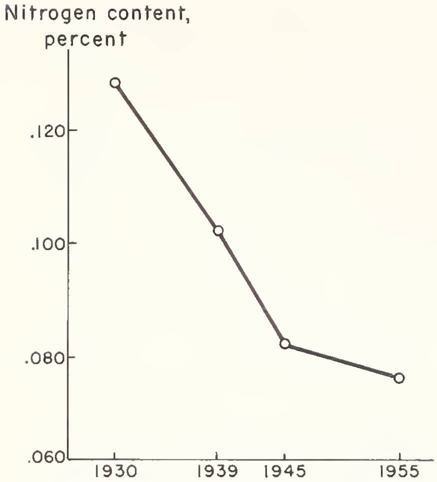
[1] Total amounts of N, P_2O_5, and K_2O per acre used over the 5-year rotation under the high fertilizer level for systems with no sod crops were 270, 540, and 250 pounds, respectively. Corresponding amounts for a typical system with 2 years of sod crop were 160, 440, and 280 pounds per acre. The low fertilizer level was one-fourth that of the high.
[2] Figures given are for earthworms counted per 240 feet of furrows when the plots were plowed.

In summary the study showed earthworm counts were affected by wood chip treatments more than were weight losses from the sticks; wood chips were the dominant factor affecting either index of biological activity in this experiment; and trends showed more earthworms and more decomposition of the sticks when cover crops and sod crops were used in the rotation, and as the amount of fertilizer was increased.

Nebraska

CULTIVATION SPEEDS NITROGEN LOSS FROM CHESTNUT SOIL

H. F. Rhoades and J. S. Russell, Lincoln. --Losses of nitrogen from the surface foot of Rosebud soil ranged from 40 percent for land cropped continuously to winter wheat to 52 percent for continuous intertilled crops and fallow (see accompanying table). These large losses of nitrogen were obtained from the rotation plots at the Box Butte Experiment Farm, Alliance, in western Nebraska during the period 1930 to 1955. Plant symptoms of nitrogen deficiency in the rotation plots and the response of winter wheat after fallow to nitrogen fertilizer in other experiments indicate that the present level of soil nitrogen in the rotation plots is inadequate for optimum crop production. Results from



Change in nitrogen content in the 0- to 6-inch depth of Rosebud soil, Alliance, Nebr., 1930-1955.

this study further suggests that more attention should be given to the problem of maintaining adequate amounts of nitrogen and associated organic matter in western Nebraska soils for sustained crop production.

Most of the nitrogen loss from Rosebud soil occurred during the 15-year period from 1930 to 1945. The loss with time of cultivation was essentially linear during that period (see accompanying figure). However, it is evident that when the nitrogen level of the soil in 1955 is also considered, a curvilinear relationship exists between nitrogen content of the soil and time of cultivation. Presumably the nitrogen level of the soil is approaching an equilibrium value in this study.

Loss of nitrogen from Rosebud soil in relation to the proportion of intertilled crops, Box Butte Experiment Farm, Alliance, Nebr., 1930 to 1945

Proportion of intertilled crops and fallow	Nitrogen loss based on nitrogen content in 1930		
	0- to 6-inch depth	6- to 12-inch depth	0- to 12-inch depth
Percent	*Percent*	*Percent*	*Percent*
100	56	49	52
67	55	49	52
60	48	44	46
40	45	43	44
33	45	47	46
20	42	42	42
0	37	42	40

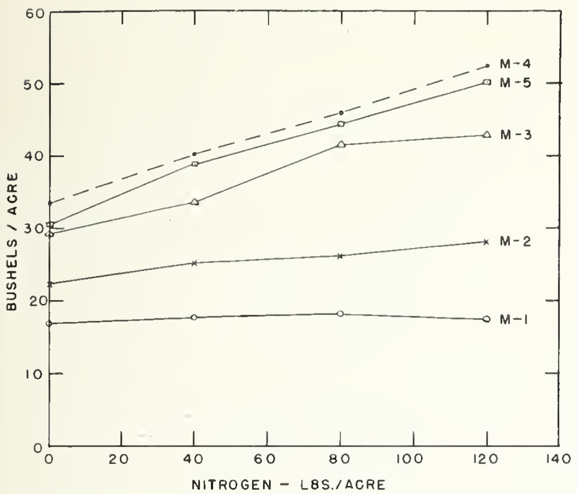
In general, nitrogen losses from Rosebud soil were greater as the proportion of intertilled crops to small grains increased. As seen in the table, this trend is especially noticeable in the 0- to 6-inch depth of soil, which is the depth most influenced by cultivation. Substitution of fallow for an intertilled crop had relatively little effect on soil nitrogen losses. In contrast, the substitution of fallow for small grain prior to an intertilled crop increased the loss of nitrogen. However, the substitution of fallow for small grain prior to winter wheat had relatively little effect on the loss of soil nitrogen.

Texas

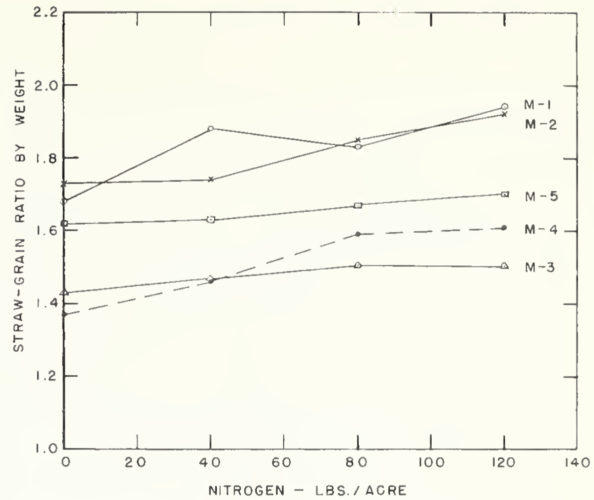
MOISTURE CONTROLS WHEAT RESPONSE TO NITROGEN

Marvin E. Jensen, Amarillo.--In an irrigated wheat experiment conducted in 1955-56, the grain yield from equal applications of nitrogen increased with higher soil moisture levels up to the highest moisture level. Here the yield dropped slightly and the straw-grain ratio increased. The results of this experiment indicate that even under irrigation the response to fertilizer is dependent on proper water management.

The two accompanying graphs show that water has a greater effect on yield and straw-grain ratio than nitrogen fertilizer. Without adequate soil moisture little or no



THE EFFECT OF SOIL MOISTURE AND NITROGEN ON THE YIELD OF IRRIGATED WINTER WHEAT. AMARILLO EXPERIMENT STATION, 1956.



THE EFFECT OF SOIL MOISTURE AND NITROGEN ON THE STRAW-GRAIN RATIO OF IRRIGATED WINTER WHEAT. AMARILLO EXPERIMENT STATION, 1956.

economic response to nitrogen can be expected on this soil. The total material produced, grain and straw, was practically identical on the M-4 and M-5 moisture treatments. The results indicate that with a lack of soil moisture and with excessive irrigation the straw-grain ratio is high. The most efficient production of grain with the least amount of straw occurred with a medium soil moisture level.

This experiment was conducted on Pullman silty clay loam having an available water-storage capacity of about 12 inches in a 6-foot profile. All fertilizer treatments were superimposed on each moisture treatment and replicated four times. The moisture treatments were identical from October 1955 through February 1956. All plots received a preplanting irrigation which wetted the soil to a depth of 6 feet. Two additional light irrigations were applied after planting to improve the stand. In the first week of February, 1.77 inches of moisture was received in the form of snow. With these irrigations and precipitation, adequate soil moisture was maintained on all plots until early spring when the different moisture levels were initiated. As the growth of wheat increased in March, the various soil moisture treatment plots were irrigated when the mean weighted soil moisture tension reached the following levels:

- M-1 No spring irrigation.
- M-2 One spring application at the jointing stage.
- M-3 Irrigated when the weighted mean soil-moisture tension approached nine atmospheres.
- M-4 Irrigated when the weighted mean soil-moisture tension approached four atmospheres.
- M-5 Irrigated when the weighted mean soil-moisture tension approached one atmosphere.

The weighted mean tension was obtained by weighting the tension in quarters of the depletion zone by 4, 3, 2, and 1 consecutively beginning at the top quarter.

Only 0.35 inch of rainfall was received from February 4 until May 23 when the wheat was in the soft-dough stage. From May 23 to May 31, 4.89 inches of rain was received.

New Mexico

ALFALFA RESPONDS IN 1955 TO P_2O_5 APPLIED IN 1952

James A. Burr, Tucumcari.--Alfalfa, after 4 years of production, is still showing a marked response to an application of P_2O_5 made in 1952.

A cooperative fertilizer trial was started in 1952 to determine the amount of phosphorus required by alfalfa on the Tucumcari Irrigation Project. This experiment compared initial applications of 0, 60, 120, 240, 480, pounds of P_2O_5 per acre. The fertilizer was broadcast when the alfalfa was seeded and no fertilizer has been added since the initial application. The P_2O_5 was applied as 45 percent treble super phosphate. The soil type on this location is Tucumcari loam.

A summary of 4 years' data from the Hinman farm is given in the following table. The column showing yield per pound of P_2O_5 applied was calculated by dividing the increase in yield over the check by the rate of P_2O_5 applied. This ratio indicates that the most efficient rate for the 4 years lies between 120 and 240 pounds of P_2O_5. However, the 480 pound rate is still significantly outyielding all other rates and the increase in yield is more than enough to pay for the additional fertilizer. This experiment will be continued through 1956 and possibly 1957.

Alfalfa hay yields obtained from five rates of phosphorus applied in 1952, Hinman farm, Tucumcari, N. M., 1952-1955

P_2O_5 per acre (applied 1952)	Yield of Dry Hay Per Acre*					Per acre increase over check	Yield per lb. of P_2O_5 applied
	1952	1953	1954	1955	Total		
Pounds	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Pounds*
0............	5.16	4.65	3.28	3.10	16.19	--------	--------
60............	5.62	5.42	3.35	3.08	17.47	1.28	43
120............	5.62	6.56	4.24	3.38	19.81	3.62	60
240............	6.13	7.37	5.53	4.14	23.17	6.98	58
480............	6.10	7.59	6.44	5.26	25.39	9.20	38
L.S.D. 5%.......	.40	.55	.26	.48	--------	--------	--------

*Average of 6 replications. Yields are the total for five cuttings in all years except 1955; only four cuttings were taken in 1955.

The following conclusions can be drawn from these data for Tucumcari loam:

1) Heavy rates of phosphorus applied at seeding will keep alfalfa production high for at least 4 years without any additional fertilizer; 2) at least 240 pounds of P_2O_5 is needed for 4 years' production of hay; and 3) the 480 pounds produced the most hay although at this time it is not so efficient in terms of yield of hay per pound of P_2O_5 applied, as the 120 or 240 pound rates.

New Mexico

MANURE AND PHOSPHORUS HAVE HIGH RESIDUAL EFFECT

Ross W. Leamer, State College.--Ammonium nitrate applied to cotton in 1952 increased yields of grain sorghum in 1953. A small increase was obtained in 1954 but no effect of the inorganic nitrogen was apparent in 1955. Manure gave a greater increase of

cotton in 1952 and of sorghum in 1954 and 1955 than ammonium nitrate. One application of phosphorus increased yields for 4 years.

These are findings of one phase of an experiment conducted at the Northeastern Substation, Tucumcari, N. M. This experiment compared the effect of inorganic nitrogen, phosphorus, and manure applied to cotton on sorghum yields for 3 consecutive years following the cotton. Manure (20 tons per acre), treble superphosphate (200 pounds P_2O_5 per acre), and ammonium nitrate (200 pounds N per acre) were applied to Dalhart fine sandy loam before cotton was planted in 1952. Plainsman sorghum was grown in 1953, 1954, and 1955 with no additional fertilizer. The yields obtained are given in the accompanying table.

Several trends are apparent from these data: 1) Sorghum yields drop sharply when this soil is not fertilized; 2) manure was the most effective fertilizer used on the cotton; 3) manure also gave the highest sorghum yields the third and fourth years; 4) Total production from manure compared favorably with inorganic nitrogen; 5) inorganic nitrogen was best for the first year of sorghum; 6) the second year it was less effective than manure; 7) Effect of inorganic nitrogen was not apparent on the third sorghum crop; 8) phosphorus is required for maximum yields from this soil; and 9) effects of phosphorus fertilizer were apparent for at least 4 years.

Yields of cotton and grain sorghum grown on Dalhart fine sandy loam at Tucumcari, New Mexico, 1952-1955

Year	Fertilizer treatment per acre (applied 1952)			
	None	Manure 20 tons	P_2O_5 200 pounds	P_2O_5 and N 200 pounds each
	Seed cotton yield per acre			
	Pounds	*Pounds*	*Pounds*	*Pounds*
1952...............	2,450	3,180	2,770	2,670
	Grain Sorghum yield per acre*			
	Bushels	*Bushels*	*Bushels*	*Bushels*
1953...............	47.9	64.5	59.2	81.2
1954...............	35.6	55.1	44.4	48.9
1955...............	25.4	38.0	35.2	35.2
Total sorghum......	108.9	157.6	138.8	165.3

*Average of 8 replicates.

North Dakota

MANURE HAS HIGH RESIDUAL EFFECT

Howard J. Haas, Mandan.--Plots seeded to grass in 1944 and fertilized each year from 1945 to 1952, inclusive, were plowed in the fall of 1952 and uniformly cropped to wheat each year beginning with 1953. No fertilizers were applied after plowing the sod.

The following table presents the average yields of wheat obtained. The barnyard manure had been stored in a pit, and was well rotted, and contained a much higher moisture content than normal barnyard manure.

Yield of wheat on land in grass and receiving various fertilizer treatments from 1944 to 1952, Mandan, N. Dak., 1953-55

Year	Wheat, yield per acre								
	Annual fertilizer treatment 1944 to 1952*								
	Check	N	NP	NPK	2N	2N2P	2N2P2K	3N	15 ton/ acre manure
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
1953..........	9.5	12.3	12.2	13.6	15.9	18.7	17.6	20.9	19.8
1954..........	9.8	9.1	10.8	11.3	11.0	11.7	11.9	13.1	17.6
1955..........	19.4	19.0	20.0	19.2	19.9	22.7	22.2	23.8	32.9
Mean..........	12.9	13.5	14.3	14.7	15.6	17.7	17.2	19.3	23.4

*N, P, and K represent 30 pounds of nitrogen, P_2O_5, and K_2O per acre, respectively.

The results show a marked residual effect from fertilizers in 1953. The yield following the barnyard manure treatment was slightly less than that following the 3N treatment in 1953. In 1954 and 1955, the residual effect from inorganic fertilizers was much less than in 1953, while the residual effect from barnyard manure remained comparatively high.

Montana

PHOSPHATE STIMULATES EARLY GROWTH OF SPRING WHEAT

Ralph E. Campbell, Huntley.--As in previous years, a marked early growth response to phosphate fertilizer was evident in spring wheat at Huntley. This was true where concentrated superphosphate was applied alone or in combination with ammonium sulfate. The fertilizer test referred to has been carried on for 6 years with spring wheat in an alternate crop-fallow system. Each year the plots being cropped received fertilizer treatments of 0, 20, and 40 pounds of N, 40 pounds of P_2O_5, and 40 pounds of N plus 40 pounds of P_2O_5 per acre. The yields obtained are shown in the accompanying table. The crops grown have consistently shown a growth response to phosphate fertilization but, apparently due to insufficient soil moisture, the response has not been reflected in the grain yields. No growth stimulation was apparent on the nitrogen-treated plots. The 1955 yields showed a decrease from nitrogen fertilizer. The test weights also have been depressed when nitrogen was applied without phosphate.

The test is being continued to determine the accumulative effects of the fertilizer treatments now being used.

Effect of fertilizer on spring wheat yields, Huntley Branch Station, Mont., 1950-1955

Treatment per acre	Yield of grain per acre						
	1950	1951	1952	1953	1954	1955	Average
Pounds	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Check................	19.3	18.2	14.5	10.7	7.0	16.1	14.3
20 N.................	18.7	17.7	10.7	7.7	5.7	11.8	12.0
40 N.................	15.8	18.4	11.2	8.7	5.3	13.9	12.1
40 P_2O_5..............	16.5	19.2	12.0	11.5	6.9	14.4	13.4
40 N + 40 P_2O_5.......	15.6	20.0	12.7	9.7	7.6	13.4	13.3
Average..............	17.2	18.7	12.2	9.6	6.5	13.9	13.1
L.S.D. 0.05..........	N.S.*	2.2	N.S.	1.5	N.S.	2.2	

*Not significant at 0.05 level.

Washington

TISSUE TESTS, LEAF ANALYSIS GOOD GUIDES TO NITROGEN STATUS

Jack L. Nelson, Prosser.--Corn plants in a nitrogen fertility experiment at Prosser in 1955 were systematically tissue-tested for nitrate nitrogen in leaf midribs. The position of the leaf on the stalk seemed to make little difference in determining the nitrogen status. The tests were made with "nitrate powder," from a tissue testing kit. The active ingredients of the powder are 1-naphylamine, sulphanilic acid, powdered zinc, manganous sulfate, and citric acid. The tissue testing results are shown in the accompanying figure.

Total nitrogen was determined on leaf samples taken from the second leaf below the upper ear at silking. These data are shown in the accompanying table with treatment and yield data.

It can be seen that the previously accepted value of 2.8 to 2.9 percent total N in the leaf at silking is indicative of maximum yield. When the tissue test curves are compared with yields, it can be observed that yields will be reduced by nitrogen deficiency if the tissue test reading drops below a "high" reading at silking.

A tissue test for nitrate in corn is a practical tool for "trouble shooting" in the field.

Leaf nitrogen at silking and associated corn yield on virgin and alfalfa land with different nitrogen fertilizer treatments, Prosser, Wash., 1955

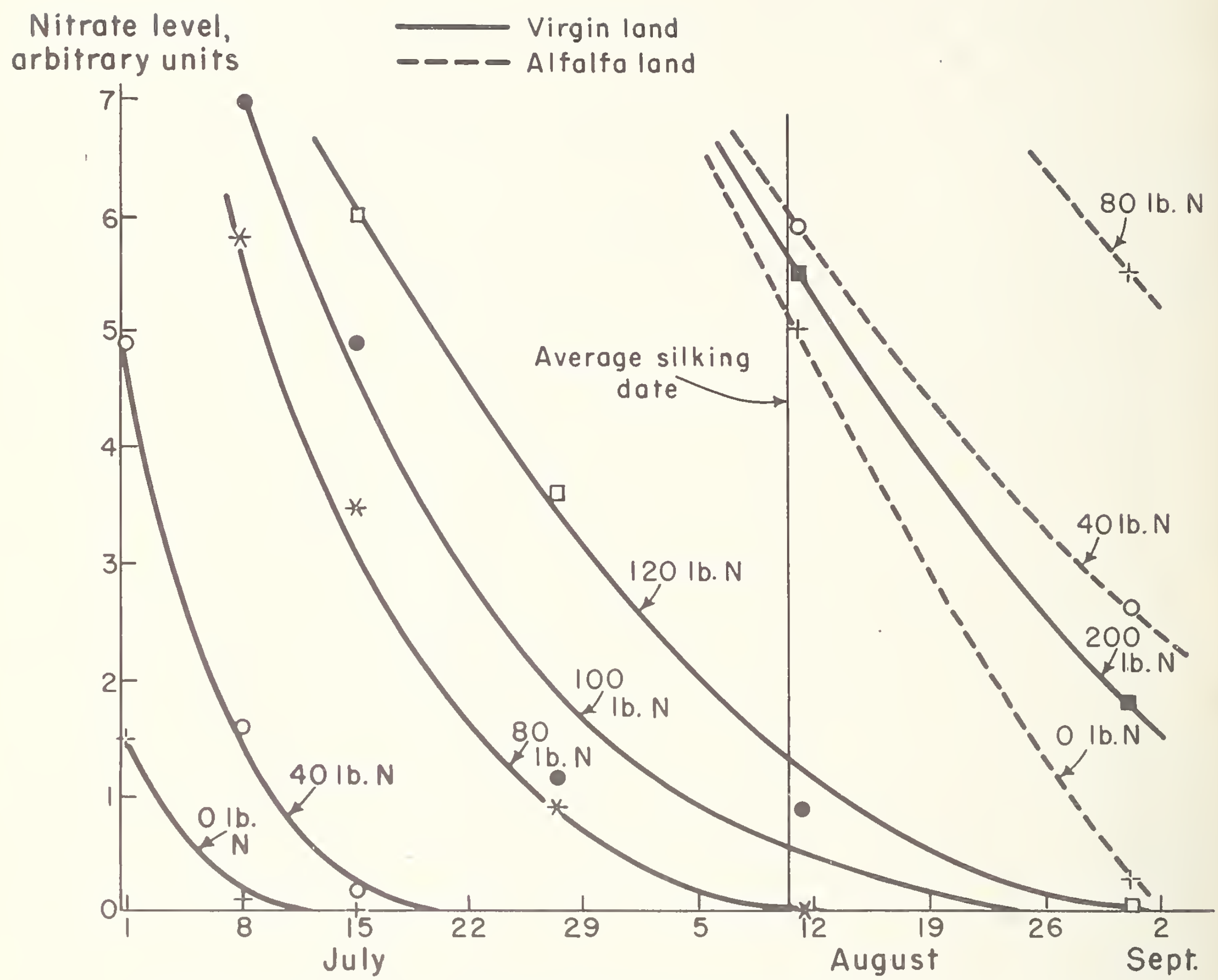
N fertilizer per acre	Yield per acre		Leaf N at silking	
	Virgin land	Alfalfa land	Virgin land	Alfalfa land
Pounds	*Bushels*	*Bushels*	*Percent*	*Percent*
0	20.9	139.6	0.89	2.73
40	55.3	160.5	0.95	2.93
80	86.0	147.7	1.54	3.10
100	98.9	158.8	1.74	3.14
120	113.8	163.1	1.95	3.13
200	144.2	161.0	2.69	3.20
L.S.D. (0.05)	19.6	13.8	0.21	0.17

SOIL STRUCTURE

Oklahoma

PLOW PAN LIMITS PERCOLATION

Harley A. Daniel, Maurice B. Cox, and Billy B. Tucker, Guthrie.--Plow pans are very extensive on the Wheatland Conservation Experiment Station, Cherokee, Oklahoma, and on similar soils throughout the State. These pans, which are compacted soil layers occurring below the plow layer, are often so dense that roots fail to penetrate them.



Effect of nitrogen fertilizer and previous cropping on nitrate in corn leaf, Prosser, Washington, 1955

Data obtained in 1953 illustrate the differences in some physical properties of various soil layers:

Soil layer	Percolation rate	Bulk Density
	Inches/Hour	*Grams/cc.*
Surface soil..................	0.777	1.327
Pan zone......................	0.350	1.431
Below pan.....................	2.732	1.291

The rate of water flow through the surface soil was about twice as rapid as through the pan zone. The percolation rate below the pan was much higher than in either the surface or pan zone. Bulk density was higher in the pan than below or above it.

Infiltration rates for certain cropped soils in the field were determined using a recording concentric ring infiltrometer. Some preliminary infiltration data obtained are as follows:

Land conditions	Infiltration rate
	Inches/Hour
Continuous wheat..........................	0.168
Formerly buffalograss sod*................	.920
Continuous wheat on friable sandy clay land	
Undisturbed surface soil.............	.102
Soil below plow pan..................	1.330
Continuous wheat on friable silt loam	
Undisturbed surface soil.............	.040
Soil below plow pan..................	6.600

*This plot has been in buffalograss for 5 years. The sod was destroyed by plowing in July before these tests were made in September.

These tests indicate that entrance of water into the soil was limited by surface soil and plow pan conditions. They also emphasize the value of grass for permeating the soil. After a plot had been in buffalograss for 5 years, the sod destroyed, and the seedbed prepared for wheat, the rate of infiltration of water into the soil was five times as high as that on the adjacent plot of continuous wheat.

Texas

CROPPING SYSTEM AFFECTS AGGREGATION AND ORGANIC MATTER CONTENT

John E. Adams and D. O. Thompson, Temple.--The corn production plots at the Blackland Experiment Station have been used to study the effect of cropping system, supplemental irrigation and nitrogen fertilizer upon the physical properties of Houston black clay. Soil samples were collected in March from the 0- to 6-inch depth and used for determinations of organic matter, percent water stable aggregates, and moisture percentage at 15 atmospheres.

The plots were established in 1950 to study the effect of irrigation, cropping system, nitrogen fertilizer, and plant spacing on corn yield. The experiment is set up as a factorial with 4 replications. Phosphoric acid was applied to all plots at the rate of 90 pounds per acre. Nitrogen applications were at the rate of 90 pounds per acre. Supplemental irrigation was applied whenever required to prevent moisture tension in the main root zone from reaching 5 atmospheres.

Summaries of the data for organic matter content and percent water stable aggregates larger than 2 mm. are presented in Tables 1 and 2. The corn-clover rotation highly significantly increased the organic matter content and significantly increased the percent of water stable aggregates as compared to continuous corn. There was a significant difference in organic matter content but no significant difference in aggregate stability between corn and clover plots in the corn-clover rotation. Nitrogen fertilizer showed no significant overall effect on either soil organic matter or aggregate stability. Nitrogen did, however, significantly increase the organic matter content on the continuous corn plots when they were considered separately. Soil samples from irrigated plots had significantly higher percent water stable aggregate than samples from non-irrigated plots. Supplemental irrigation showed no significant effect on soil organic matter.

None of the treatments or cropping systems were found to have any significant effect on the 15 atmosphere moisture percentage.

TABLE 1.--Effect of cropping practice, nitrogen fertilizer, and supplemental irrigation on organic matter content of soil, Temple, Tex.

Cropping practice	Treatment			
	No treatment	Irrigation alone	Nitrogen alone	Irrigation and nitrogen
	Organic matter content			
	Percent	*Percent*	*Percent*	*Percent*
Clover '55-Corn '56.........	2.68	2.67	2.58	2.61
Corn '55-Clover '56.........	2.52	2.57	2.53	2.51
Continuous Corn.............	2.33	2.35	2.45	2.48

TABLE 2.--Effect of cropping practice, nitrogen fertilizer, and supplemental irrigation on water-stable aggregates in soil, Temple, Tex.

Cropping practice	Treatment			
	No treatment	Irrigation alone	Nitrogen alone	Irrigation and nitrogen
	Water-stable aggregates larger than 2mm.			
	Percent	*Percent*	*Percent*	*Percent*
Clover '55-Corn '56.........	10.43	12.09	11.28	14.77
Corn '55-Clover '56.........	13.10	19.02	13.20	20.63
Continuous Corn.............	6.2	10.3	6.3	9.95

CROPPING SYSTEMS

Montana

GREEN MANURES REDUCE DRYLAND SPRING WHEAT YIELDS

T. J. Army, Bozeman.--Green manures for dryland spring wheat production have not proved desirable in major areas of Montana. Cooperative experiments in which green manure crops of sweetclover, field peas, and winter rye were used as a partial

replacement of ordinary fallow in spring wheat production were conducted at the Branch Experiment Stations at Havre, Huntley, and Moccasin. Approximately 35 years of data are available.

Results have been generally the same at the three locations. When compared to the widely used alternate crop-fallow system, green manures have had a depressing effect upon the yield of spring wheat. There was no evidence of any marked differential effect between the three types of green manures on the final yield of wheat. A summary of the data are presented in the table below:

Average wheat yields after fallow and following a green manure crop, Montana, 1911-1951

Location	Period	Precipitation*	Wheat yield per acre		
			On fallow	After green manure**	Yield decrease
		Inches	*Bushels*	*Bushels*	*Bushels*
Havre...............	1923-1951	11.7	15.3	10.9	4.4
Huntley............	1913-1951	12.9	19.0	15.3	3.7
Moccasin...........	1911-1951	15.0	17.8	16.2	1.6

*Crop year (Sept. 1 - Aug. 31) precipitation.
**Mean value of all green-manure treatments.

Soil differences may partly account for the range in magnitude of the "Yield decrease" values in the table. However, weather data at these three stations indicate that the difference in yield is apparently related to rainfall. The smallest difference between wheat yields on fallow and following a green-manure crop was at Moccasin and was associated with the highest crop year rainfall of the three locations. The largest yield reduction resulting from the use of green manures was at Havre where rainfall was the lowest.

By projecting these figures, it appears that "crop year" rainfall should exceed 16 inches before green manures are used for dryland spring wheat production in Montana.

Georgia

RESCUE GRASS AND LEGUMES OFFER YEAR-AROUND GRAZING POSSIBILITIES

B. H. Hendrickson, Watkinsville. --A series of 20 plots using 5 replicates were in a grass-legume orientation trial in 1955, for the purpose of providing information to use as guidance in setting up formal studies on this subject. They were located on Class II land of Cecil sandy loam at the Watkinsville Station.

Rescuegrass (Bromus catharticus) had already been established in 27" rows with 1-year old alfalfa plants in the middles. Crimson clover was oversown in the fall of 1954 on certain plots. A split-plot design was used to determine responses to 2 levels of nitrogen applied in the spring of 1955, on all of the plots.

The yields obtained of each component in 5 hay clippings and the total for the combinations for the calendar year 1955 are shown as averages below:

Planted crops	Nitrogen applied per acre	Yield per acre				
		Rescue-grass	Crimson clover	Alfalfa	Crab-grass	Total forage
	Pound	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Rescuegrass only.	100	2.32	-	-	.54	2.86
	33	1.21	-	-	.53	1.74
Rescuegrass + crimson clover...	100	1.65	1.05	-	.64	3.34
	33	1.12	.94		.62	2.77
Rescuegrass + Kansas alfalfa...	100	.92	-	3.08	.19	4.19
	33	.69	-	2.82	.19	3.70
Rescuegrass + crimson clover + Kansas alfalfa	100	.64	.55	3.21	.22	4.62
	33	.51	.55	2.96	.22	4.24

The following conclusions were drawn from the 1 year of data:

(1) Rescuegrass alone showed a good response to the extra 67 pounds of nitrogen and apparently used it up, as indicated by the lack of response of the following summer crabgrass yield.

(2) In the rescuegrass-crimson clover combination, rescuegrass made up three-fifths and clover two-fifths of the stand in the spring at the 100 pound nitrogen level. The stand was more nearly balanced at the 33 pound nitrogen level. Rescuegrass responded well to the extra nitrogen; the clover only slightly.

(3) In the rescuegrass-Kansas alfalfa combination, the alfalfa made up about three-fourths of the stand, and rescuegrass one-fourth. The alfalfa component alone yielded 3.08 tons per acre at the higher nitrogen level, being slightly benefited by the extra nitrogen.

(4) The alfalfa was a year old when the clover was sown in the rescuegrass-Kansas alfalfa-crimson clover combination. This somewhat suppressed the clover. The two legumes together reduced the grass growth in the spring, but the total forage yield was 4.62 tons per acre at the higher nitrogen level. Later observations showed that the alfalfa plants were weakened by the clover, presumably due to competition in the spring for light and soil moisture. The simpler combinations of one grass and one legume looked best.

Rescuegrass and crimson clover, both reseeders capable of renewing stands along with summer crabgrass, form year-around cover suitable for limited winter grazing, lush spring growth for grazing, silage, hay or commercial seed production, and some summer hay or grazing.

When rescuegrass was grown with alfalfa, the total forage production was higher, especially in summer. This mixture also provided year-around cover and was adaptable for all of the above-named farm uses except commercial seed production in this area. During hot weather, rescuegrass did not seriously compete with the alfalfa--an essential requirement for good alfalfa yields. The rescuegrass reseeded itself satisfactorily regardless of frequent cuttings. This combination should also maintain or renew itself for many years.

Yields were low in 1955 as the rainfall totaled only 36.02 inches, 27 percent below the long-time average of 49.19 inches. Following a dry spring, there was a monthly deficiency of 2.10 inches to 1.20 inches during the June to October period.

Basic fertilization for all of the plots consisted of 1 ton per acre of lime prior to initial plantings, and annual fall applications of 500 pounds per acre of 0-12-12 fertilizer with 25 pounds per acre of borax equivalent, plus 100 pounds per acre K_2O as muriate of potash after first spring clipping of alfalfas.

RESIDUE MANAGEMENT

Maryland

USE OF NITROGEN IN DECOMPOSITION OF RESIDUES

F. E. Allison, Beltsville.--An article in the March 1956 issue of Agricultural Research, dealing with the fertilization of crop residues, seems to have been interpreted by some readers as a recommendation that nitrogen additions should not be used as a supplement to such residue additions. A more detailed and clearer statement of the subject appeared in Soil Science Society of America Proceedings, vol. 19, p. 210 (1955). The main facts that these articles attempted to bring out are the following:

Crop residues containing less than about 1.5 to 1.7 percent nitrogen on a dry-weight basis should have sufficient supplementary nitrogen added to bring the total nitrogen content to at least this level. If the residue is straw, cornstalks, or a similar carbonaceous material, about 15 to 20 pounds of nitrogen per ton is usually adequate to overcome the depressing effect of the residue on crop yields. This amount of nitrogen would be in addition to that ordinarily applied to the crop where no residue is added.

The most efficient use of this nitrogen usually can be realized if the extra nitrogen, as well as the usual amount, is added directly to the crop at the time when it needs it most rather than to the crop residue the preceding fall. This is particularly true in the warmer portions of the humid region where losses from uncropped soils through leaching during the fall, winter, and spring are often large. If moisture and temperature are favorable, uncropped soils of normal fertility commonly release enough nitrogen from the soil organic matter to meet most or all of the needs of the micro-organisms that decompose the crop residues. If the conditions are not favorable for decomposition, the addition of nitrogen will certainly not have much effect. Under many cropping conditions nitrate nitrogen tends to accumulate at the end of the growing season. Crop residues added at this time may utilize much of this nitrogen that otherwise might be lost by leaching during the between-seasons period. Even in drier regions, where a summer fallow system is used, there would seem to be little reason for applying the extra nitrogen to crop residues a year before a crop is grown. The nitrogen released from the soil should be adequate for a good rate of decomposition. Furthermore, rapid and complete decomposition are not necessarily essential or desirable if adequate nitrogen is applied to the subsequent crop to prevent harmful effects on crop growth.

The addition of nitrogen to crop residues does not result in the retention in the soil of any appreciably greater percentage of the carbon of the residue. The idea that much more of such carbon is retained following nitrogen fertilization has become somewhat prevalent in certain localities. Actually, if soil nitrogen is very deficient, its addition will speed up decomposition and also the loss of carbon as carbon dioxide. When the residue is thoroughly decomposed, however, the residual carbon (humus) left in the soil will be nearly the same whether decomposition proceeded rapidly or slowly. The composition of the residues is more important in determining carbon loss (or retention) than is the nitrogen level. Sugars, for example, decompose rapidly and fairly completely to carbon dioxide and water, whereas lignin tends to remain in a partly decomposed condition.

Nitrogen additions to soils over a period of years do often result in a higher level of soil organic matter than where such additions are not made. This is due, however, to the larger crops produced and to the larger quantities of carbon returned in the residues. Other factors that increase crop yields and residues, such as additions of phosphorus or potash, better varieties, or improved moisture conditions are likely to have the same effect.

South Carolina

HEAVY MULCH INCREASES SUDANGRASS YIELD

J. H. Smith, Clemson.--Evidence has been obtained which shows that relatively large amounts of cornstalk mulch can be used without harmful effects. An investigation to study the microbiological aspects of mulch tillage was set up at Clemson using Cecil soil in small frame plots 2 feet by 3 feet under field conditions. Thirty-three tons per acre of ground cornstalks were applied (1) all on the surface, (2) mixed in the top 3 inches of soil, and (3) mixed throughout the top 6 inches of soil.

When the plots were filled with soil, the equivalent of 20 pounds of nitrogen per acre was added to all the plots. All plots were planted with sudangrass. This crop was used as an indicator, to study nitrogen uptake or tie-up due to microbiological action. After the first cutting, 20 pounds of nitrogen per acre was added to one set and 70 pounds of nitrogen per acre was added to another. After the second cutting an additional 70 pounds of nitrogen per acre was added to the high nitrogen treatment plots. This made a total of 40 pounds of nitrogen per acre for one treatment and 160 pounds for the other. For simplicity of presentation in the table below, the nitrogen rates were combined and average values are given.

Yield of sudangrass and nitrogen recovery as influenced by residue management

Residue treatment	Yield of sudangrass per acre (oven dry)				Nitrogen recovered in grass per acre
	Cutting date				
	8-8-55	8-30-55	10-27-55	Total	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Mulch on surface..........	2911	3179	3748	9838	244
Mixed 3 in. deep..........	1455	2677	2560	6692	174
Mixed 6 in. deep..........	1556	2526	2928	7010	177
Check, no residue.........	2008	2342	2526	6876	164

The yield of sudangrass was sharply depressed with the 20-pound nitrogen rate when the residues were incorporated in the soil. At the same nitrogen rate, the mulch gave an increase in sudangrass yield over the three other treatments. As additional nitrogen was applied, the depression of yield below the check for the incorporated residue plots was eliminated and they produced slightly more growth than the check plots for the second cutting. In total yield for three cuttings, the mulch plots produced 40 to 47 percent more sudangrass than the check or the two incorporated treatments. The total yields for the latter three treatments were amazingly uniform.

On the average, 100 pounds of nitrogen per acre was applied to all plots. The grass on the check plots recovered 164 pounds of nitrogen per acre. The recovery from the incorporated plots was only slightly higher. It appears that little if any nitrogen was made available for the grass by the incorporated residue. Of the 244 pounds recovered by the grass on the mulch plot, about 80 pounds came from the mulch and the soil. This may in part account for the yield increase obtained with the mulch.

Moisture blocks were used in all plots. The mulch plots retained more moisture than any of the other plots and the check plots retained the least moisture. Moisture retention through heavy mulch application may be a contributing factor along with additional nitrogen release in obtaining the sizeable yield increases on the mulch plots.

Nebraska

MULCHING CONCENTRATES ACID-SOLUBLE PHOSPHORUS AT SURFACE

T. M. McCalla, Lincoln.--In plots that have been stubble-mulched and plowed for 17 years there has been a redistribution of the acid-soluble phosphorus in the surface soil. The difference in acid-soluble phosphorus content between subtilled and plowed plots indicates that phosphorus has been added to the surface inch of soil from organic sources. The source of this phosphorus could be either from the mineralization of phosphorus in crop residues or to a more complete mineralization of the phosphorus from organic forms already present. This accumulation of phosphorus modifies the surface layers of soil and may be favorable for increasing the decomposition rate of crop residues. The availability of phosphorus to plants would also be affected by an accumulation of phosphorus in the surface inch of soil. The relative quantity of plant roots in the various soil horizons and the moisture relationships in the surface inch of soil would have a direct bearing on this availability.

Results are shown in the following table:

Effect of stubble mulching and plowing on the amount of acid-soluble phosphorus in the soil, Nebraska

Cropping**	Acid-soluble phosphorus*							
	Sampling depth (inches)							
	Stubble-mulched				Plowed			
	0-1	1-3	3-6	0-6	0-1	1-3	3-6	0-6
	P.P.M.	*P.P.M.*	*P.P.M.*	*P.P.M.*	*P.P.M.*	*P.P.M.*	*P.P.M.*	*P.P.M.*
Corn, oats, wheat.	22.8	18.2	13.4	16.6	19.4	19.1	19.5	19.3
Corn, oats, wheat.	25.5	21.3	14.6	18.7	20.8	22.5	15.7	18.8
Sweetclover, sweetclover, wheat,oats,corn..	24.5	22.3	17.9	20.5	18.5	18.1	17.4	17.8
Mean.............	24.3	20.6	15.3	18.6	19.5	19.9	17.5	18.6

*Each value represents the mean of determinations on three plots. Determinations were made on triplicate extracts and averaged.
**Plots in crop underlined when sampled.

Texas

PLANTER DEVELOPED TO SEED THROUGH RESIDUES WITH MINIMUM DISTURBANCE

C. E. Van Doren, R. C. Reeder, and M. E. Jensen, Amarillo.--Since the development of stubble mulch tillage, there has been a need for a better means of seeding crops with a minimum of residue and soil disturbance. Seeding equipment now being used by farmers covers much of the surface residues left by stubble mulch tillage and reduces its effectiveness for controlling wind erosion.

In 1955, additional research studies on residue management were initiated involving the use of chemicals for control of weeds instead of plowing. Seeding equipment on the market did not do a satisfactory job of seeding in undisturbed soil and it was necessary to assemble special seeding equipment for this purpose.

A drill was assembled on a double tool bar with a three point hitch. Each seeding unit was made with an 18 inch heavy duty rolling coulter followed by a narrow seed shoe and a small rubber-tired press wheel. The units were mounted independently on the tool bar and were staggered to aid in clearing trash. Each unit operated independently with the seeding depth regulated by coil compression springs. The drill was raised by the tractor hydraulic system and the overall depth of seeding was controlled by gage wheels. A rear view is shown in Figure 1.

A planter for seeding sorghum was also assembled by attaching seeding units to a single tool bar and mounting seed boxes on each individual unit. A view of the planter is shown in Figure 2. Good stands of sorghum were obtained using this equipment, and only minor modifications will be necessary for excellent performance.

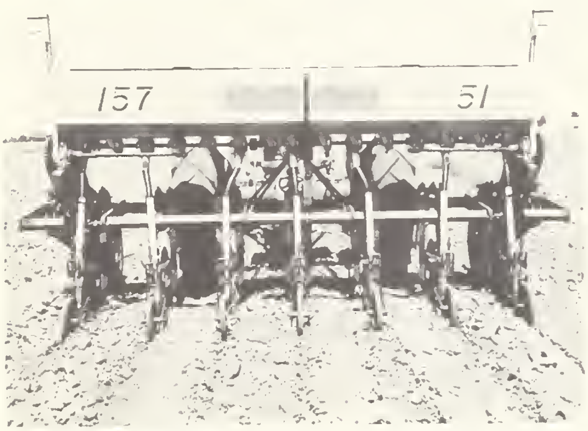


Figure 1.--Coulter type drill assembled at the Amarillo Experiment Station for seeding through residues with a minimum of residue and soil disturbance. The openers are spaced on 16-inch centers for drilling sorghum. One additional opener will be placed between each of these for wheat seeding.

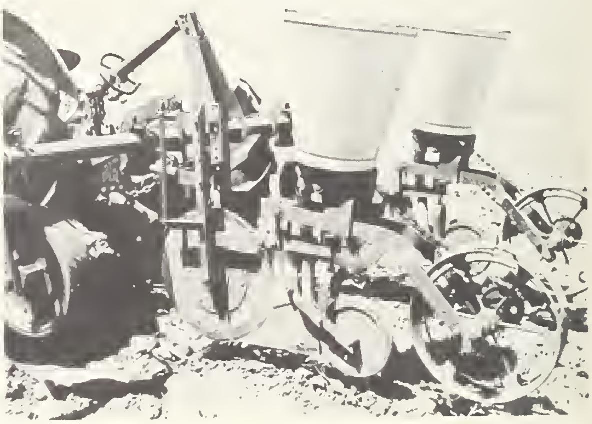


Figure 2.--Closeup view of the coulter type drill unit showing the shoe, press wheel and the type of mounting used for planting sorghum, Amarillo, Texas.

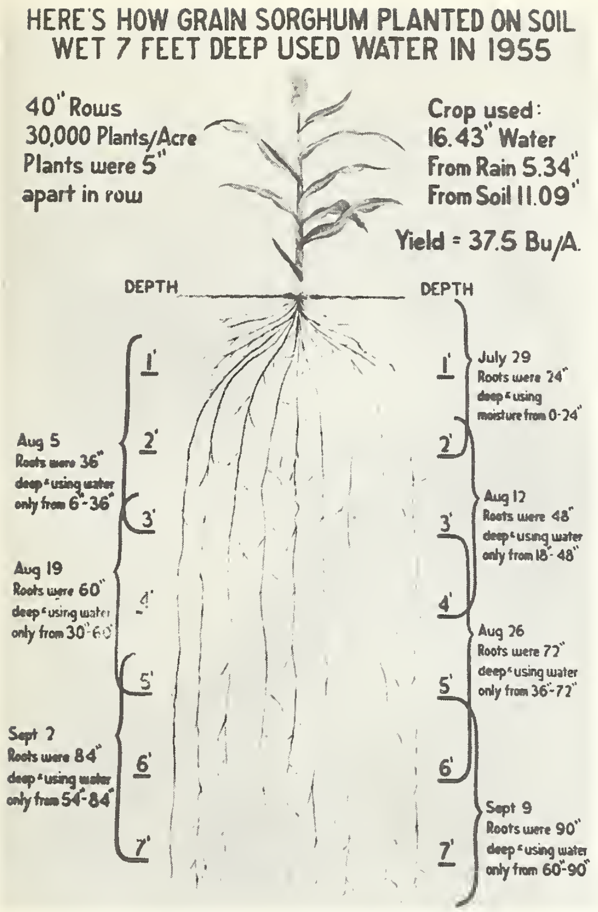
MOISTURE CONSERVATION

Kansas

GRAIN SORGHUMS GO DEEP FOR WATER UNDER DRYLAND CONDITIONS

Paul L. Brown, Hays.--In 1955, gypsum blocks were used to determine depth and extraction pattern of moisture by grain sorghum roots. The soil was wet to field capacity to a depth of 7 feet at planting time, and rainfall was the only source of water addition after the crop was planted. Rainfall was far short of crop requirements and was not sufficient to recharge the soil moisture to a depth of more than a few inches. The soil was Tripp silt loam, a well-drained alluvial soil designated by the Soil Conservation Service as 1M 4 X.

Sorghum was planted in 40-inch rows and plants were spaced 5 inches apart in the row, giving a population of 30,000 plants per acre. Gypsum blocks were buried at 6, 12, 18, 30, 42, 54, 66, 78, and 90 inches. When a block resistance reached 80,000 ohms, the soil-moisture content was considered to be at or near the permanent wilting percentage.



Root penetration and moisture extraction zones for grain sorghum, Hays, Kans., 1955.

Although block resistance continued to increase as the season progressed, the amount of additional water absorption was believed to be quite small.

Root development and zones of water absorption by grain sorghum in 1955 are shown in the accompanying figure. The crop used 16.43 inches of water during the season of which 5.34 inches came from rainfall and 11.09 inches came from stored soil moisture. The grain yield was 37.5 bushels per acre. Moisture extraction indicating root penetration to a depth of at least 90 inches had occurred by September 9 as evidenced by increased block resistance at this depth. Extraction may have occurred at depths greater than 90 inches but there were no measurements of moisture at greater depths. Soil moisture at the 90-inch depth was considerably below field capacity at planting time and it is probable that the low water content slowed root penetration.

The crop emerged on June 18. During the period June 18 to July 29, measurable water extraction occurred only in the surface 24 inches. The crop was completely headed on August 19, and at that time extraction was observed at the 60-inch depth with most of the water coming from the 30-inch to 60-inch zone. The crop was essentially mature on September 15.

Measurable water absorption was confined to a zone of only 2 to 3 feet at any one time. As shown in the figure, the zone progressed downward with time. Once roots had entered a soil zone the moisture content was reduced to the permanent wilting percentage in 2 to 3 weeks.

Kansas

WIND SPEED AND SOIL MOISTURE AFFECT TRANSPIRATION OF WHEAT

N. P. Woodruff and R. J. Hanks, Manhattan.--Transpiration of wheat plants as influenced by wind speed and soil-moisture content was studied in preliminary experiments. Tests were made in May 1956 when the plants were in the early heading stage. A summary of the data is shown in Figures 1 and 2.

When the soil moisture content was slightly above the permanent wilting percentage, the average relative transpiration was 10.8 for a wind speed of 24.5 mph, 7.4 for a wind speed of 12.7 mph, and 2.9 for a wind speed of 5.5 mph. When the soil moisture content was near field capacity the relative transpiration averaged 16.1 for a wind speed of 24.5 mph and 7.8 for a wind speed of 5.5 mph. Thus, under constant soil moisture conditions, transpiration is increased from 2 to 3 times with an increase of wind speed from 5.5 to 24.5 mph. With wind speed constant, transpiration is increased about 1.5

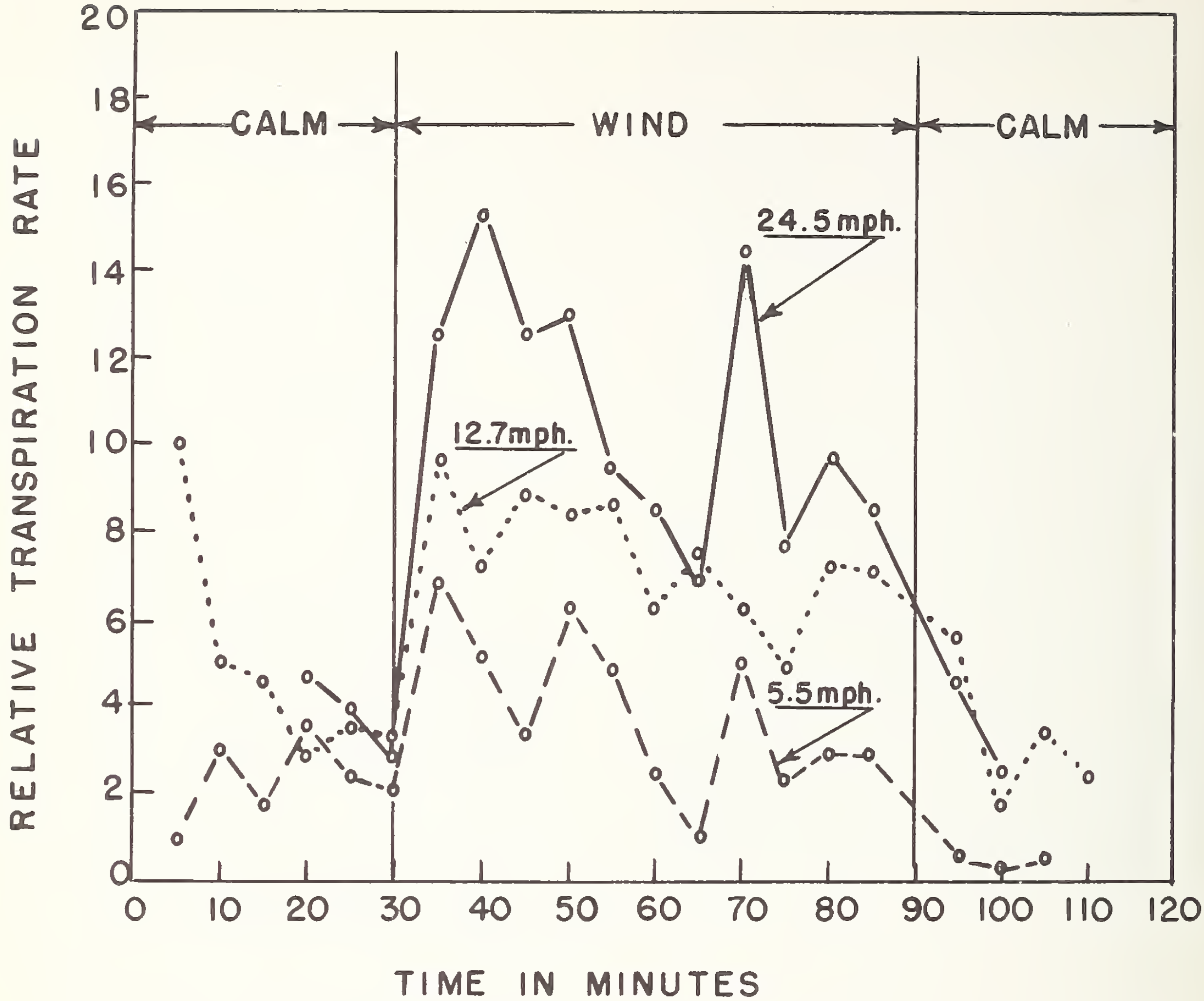


Figure 1.--Influence of wind speed on transpiration of wheat grown in soil with the moisture content near the permanent wilting percentage.

to 2 times by increasing the soil moisture content from near permanent wilting percentage to field capacity.

The relation of transpiration to time after the onset of wind was quite similar under all conditions studied. The transpiration rate was highest right after the wind had started blowing and decreased slowly with time.

Further studies of a similar nature are underway to determine the influence of stage of growth of the wheat plant in addition to wind speed and soil-moisture content.

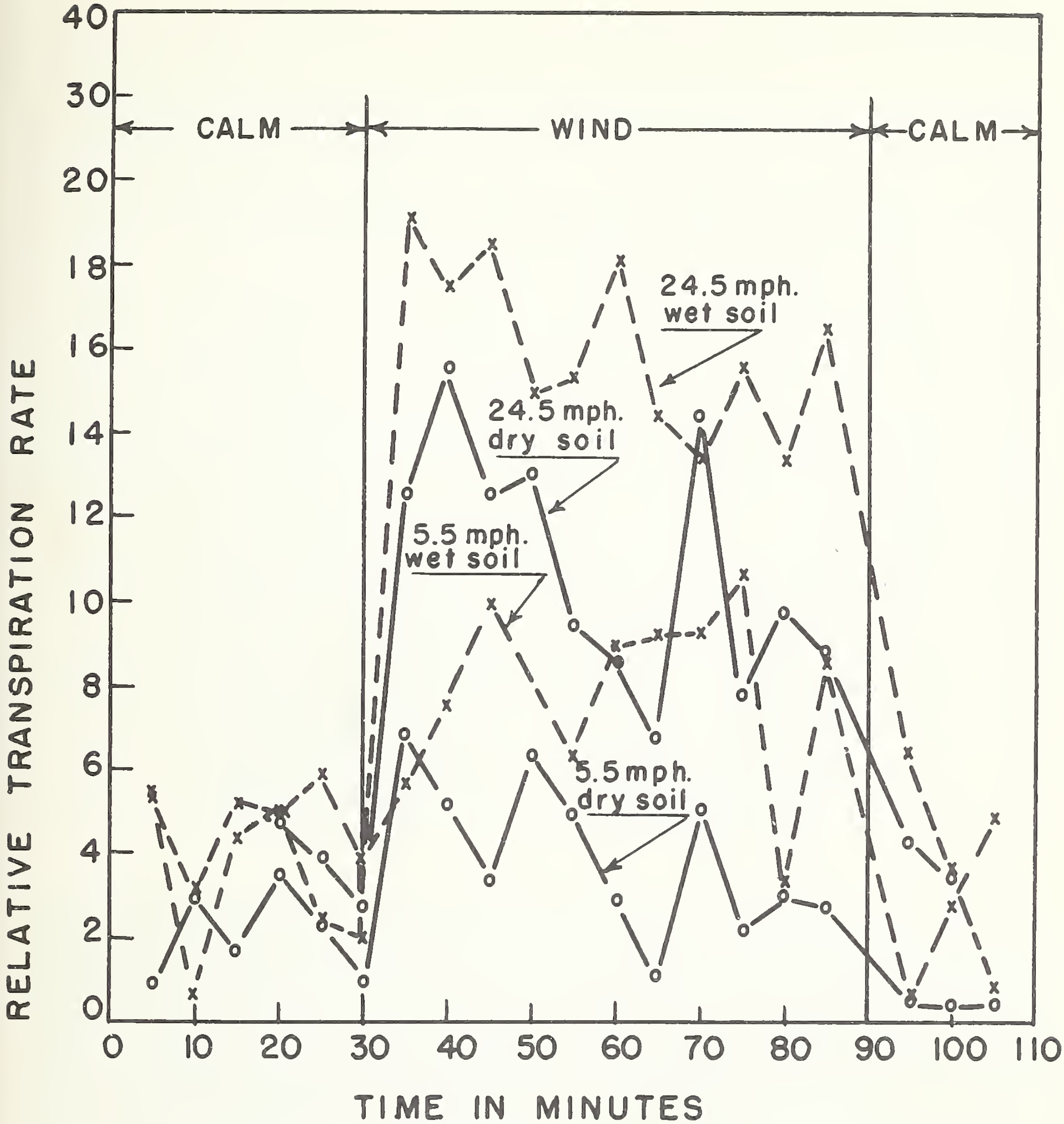


Figure 2.--Influence of wind speed and soil-moisture content on transpiration of wheat.

Wisconsin

ABOVE AVERAGE RAINFALL REPLENISHES SOIL MOISTURE DEFICIENCY

Neal E. Minshall, Madison, Wisconsin. --Precipitation at Fennimore for April-June 1956 totaled 12.77 inches, which is about 1 inch above normal. A total of 4.7 inches falling in a 12-day period from April 12 to May 6 almost completely eliminated the soil moisture deficiency which developed during the summer and fall of 1955. Some of the

June rains were at high intensities, but of such short duration that they caused little surface runoff.

A landowner in one watershed is again trying high fertility on a 5-acre cornfield. Two different plant populations on this field, approximately 14,000 and 20,000 plants per acre, should give some interesting results on moisture use and crop yields.

Precipitation at Colby, Wis., during May and June totaled 10.35 inches. There was about 2 inches of surface runoff during this period. There were no high intensities of sufficient duration to cause high rates of runoff.

TILLAGE AND CULTURAL PRACTICES

Idaho

FALL CHISELING INCREASES ANNUAL CROPPED SPRING WHEAT YIELDS

F. H. Siddoway, St. Anthony.--Chiseling in the fall of 1954 resulted in an increase of 5.8 bushels of Baart spring wheat per acre. Fall-chiseled plots averaged 16.1 bushels per acre compared with 10.3 bushels for plots not fall-chiseled. Chisel tools were spaced 3 feet apart and operated to a depth of 10 inches.

There was an average increase of 5.73 inches of available soil moisture within a 6-foot soil depth between the harvest of the 1954 crop and drilling of the 1955 crop on the fall-chiseled plots. The check plots averaged a gain of only 3.30 inches of moisture during the same period.

There was no significant difference between spring wheat yields due to the spring broadcase application of 0, 20, 40, or 80 pounds of nitrogen per acre. The straw-grain ratio increased with nitrogen increments, as did the protein content of the grain. Neither of these increases was significant, however.

Although this study has been established for only one year, moisture rather than available nitrogen appears to be the primary factor limiting annual spring grain production in this area.

Annual cropped spring wheat on plots not fall-chiseled, Idaho, 1955 (Blackboard 36 inches high).

Annual cropped spring wheat on plots fall chiseled, Idaho, 1956 (Blackboard 36 inches high)

Iowa

SOIL TEMPERATURE INFLUENCES EARLY CORN GROWTH

W. O. Willis and W. E. Larson, Ames.--Soil temperature studies under different mulch tillage systems indicate that low temperatures are a major cause for poor early growth and reduced yields of corn.

A field experiment was conducted in 1955 to determine the effects of soil temperature in bare soil and in soil covered with 2-1/2 tons per acre of oat-straw mulch on corn growth.

Lead-covered heating cables were buried 8 inches (4 inches on each side of the row) apart and 5 inches deep in the soil. Power to the cables was controlled by thermoregulators which were set to give warmer soil temperatures than from the unheated treatments. The results showed that corn in the heated plots emerged 2 to 3 days earlier than in the unheated plots. Early corn growth was also markedly increased by increasing the soil temperatures. When maintained at the same soil temperature, corn growth on plots receiving mulch appeared to be about equal to corn growth on bare soil. Soil temperatures under mulch not receiving heat were lower and corn growth poorer than from unheated bare soil treatments. Photographs of the corn from the five experimental treatments 3 and 6 weeks after planting are given in figures 1 and 2, respectively.

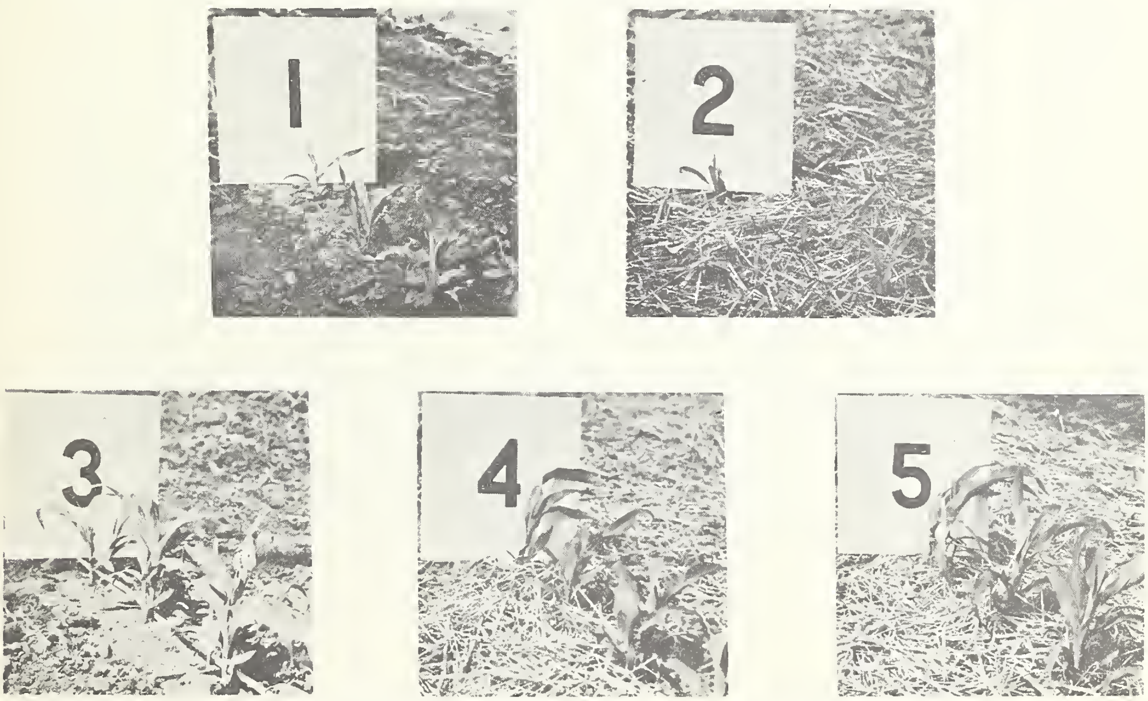


Figure 1.--Corn plants when 3 weeks old as affected by temperature, with and without mulch cover.

1. Bare, unheated
2. Mulch, unheated.
3. Bare, heated, 75° F*
4. Mulch, heated, 67° F*
5. Mulch, heated, 71° F*

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* Thermoregulator setting.

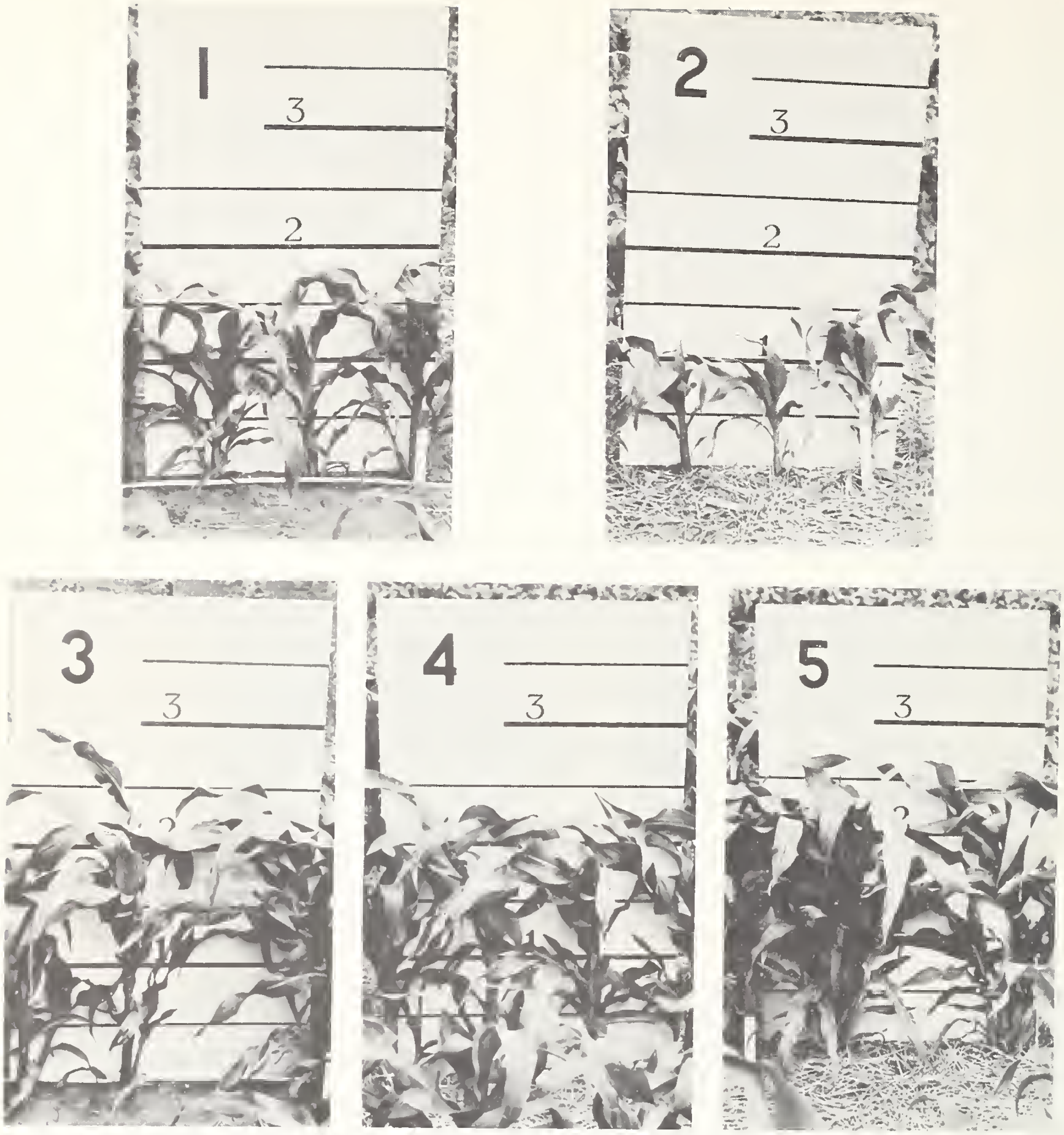


Figure 2.--Corn plants when 6 weeks old as affected by temperature with and without mulch cover.

1. Bare, unheated
2. Mulch, unheated
3. Bare, heated, 75° F*
4. Mulch, heated, 67° F*
5. Mulch, heated, 71° F*

* Thermoregulator setting.

In general, the experimental results emphasize the importance of considering soil temperature when planning any tillage system. The results also indicate that the lower soil temperatures created by a mulch tillage system are a major reason for the poor early growth and lower yields of corn that often occur with such a system in this region.

Illinois

EFFICIENCY OF WATER USE IS GOVERNED BY SOIL CHARACTERISTICS

D. B. Peters, Urbana.--The first year's results of an extensive survey of selected soil types in Illinois indicate that soil profile characteristics, as well as profile recharge, will govern the efficiency of water use. On those soil types that have impervious subsoil characteristics, corn is unable to efficiently extract the available soil moisture, probably due to inability to form an extensive root system. This type is shown graphically in figure 1 by the moisture extraction patterns for Cisne silt loam, a soil having a dense impervious layer at a depth of 20 to 30 inches. Below this depth the corn was unable to utilize the water. Conversely, for a soil having a uniform profile and under similar rainfall conditions, the moisture extraction patterns show the ability of corn to extract water from the entire depth sampled. This type is characterized graphically in figure 2 by Tama silt loam.

An examination of the yield and water use data given in the table reveals two interesting facts. The first is the rather remarkable uniformity of water efficiency for the various soil types. Secondly, the deviations from this narrow range in water efficiency are reflected by those soils considered to be in the problem class, that is, the Cisne, Elliott, and Clary soils. An examination of the moisture extraction patterns indicates that marked deviations in water efficiency are reflected in two ways. Any restricting layer, such as that in the Cisne, prevents the plant from extracting water at the lower depths. This places the plants in a moisture deficit regime during the critical periods of July and August. Secondly, those soils which show extraction patterns whereby the plant is extracting water at the higher stresses also show reduced water efficiency. This type is characteristic of the Clary and Elliott series.

Yield and water use of corn for selected soil types[1]

Soil type	Yield per acre	Plants per acre	Water used[2]	Yield per inch of water
	Bushels	*Number*	*Inches*	*Bushels*
Bonpas silty clay loam.....	79.9	8,072	17.8	4.5
Cisne silt loam...........	78.2	9,313	20.4	4.0
Clary silt loam...........	54.5	8,497	14.7	4.0
Cowden silt loam..........	86.7	11,121	16.7	5.2
Elliott silt loam.........	61.4	14,748	16.6	3.8
Flanagan silt loam........	81.0	16,000	13.8	5.9
Herrick silt loam.........	85.3	12,386	15.2	5.6
Patton silty clay loam.....	98.6	10,948	18.3	5.4
Saybrook silt loam........	85.7	15,761	16.6	5.2
Swygert silt loam.........	64.7	12,720	11.5	5.6
Tama silt loam............	94.4	11,765	18.5	5.1
Hoopston..................	78.5	14,453	-	-

[1] Based on 1 year's data. Year-to-year differences in rainfall pattern as well as differences in management may change the water use and water efficiency for individual soils.
[2] Includes runoff as well as plant use.

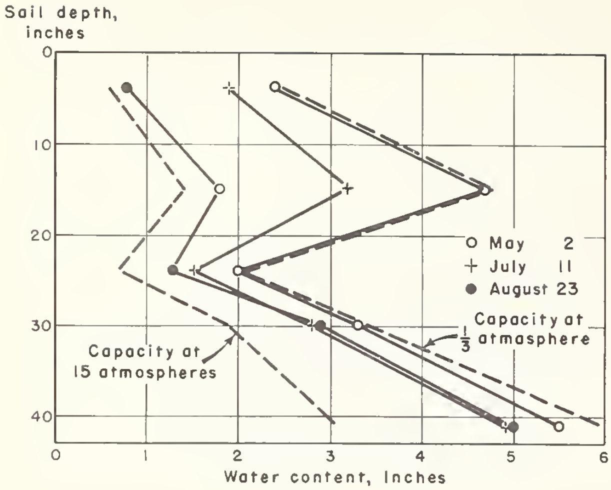


Figure 1.--Water extraction pattern for Cisne silt loam, Illinois, 1955

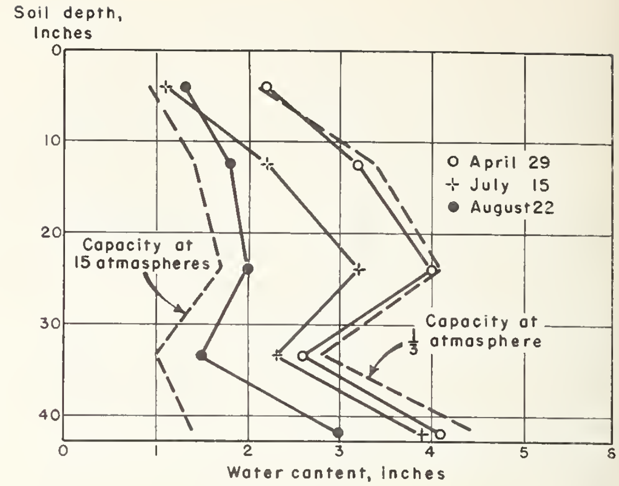


Figure 2.--Water extraction pattern for Tama silt loam, Illinois, 1955

Kansas

HIGH SOIL MOISTURE FAVORS SEEDLING EMERGENCE

R. J. Hanks and F. C. Thorp, Manhattan.--Seedling emergence of wheat, grain sorghum, and soybeans for a given soil crust strength were found to depend upon the soil moisture content. A sample of the results follows:

Soil moisture content	Seedling emergence								
	Wheat			Grain sorghum			Soybeans		
	Crust strength*			Crust strength*			Crust strength*		
	100	400	800	100	400	800	100	400	800
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Field capacity....	86	65	59	68	63	52	75	72	66
Half of the available water remaining..........	86	57	35	58	46	22	75	60	38
Quarter of the available water remaining........	74	44	31	50	41	18	55	34	31

* Crust strength in millibars (modulus of rupture) for dry soil.

For any given crust strength, seedling emergence decreased as the soil moisture content decreased for all of the plants studied. For any given moisture level, seedling emergence decreased as crust strength increased. These data emphasize the need for considering soil moisture where crusting is a problem.

Previous work has shown that the strength of a crust per se is dependent upon the soil moisture content of the crust. As soil moisture decreases crust strength increases. Thus, if crusting is a problem, seedling emergence could be enhanced in two ways by maintaining soil moisture at a high level: because 1) seedling emergence for a constant

Seedlings emerging through a "hard" crust showing large scale crust breakage.

Seedlings emerging through a "soft" crust showing localized crust breakage.

crust strength is greater at the high moisture levels, and 2) crust strength is less at higher moisture levels. This assumes that other factors such as aeration etc. are not limiting.

Seedlings emerging through a "hard" and "soft" crust are shown in the accompanying photographs.

Nebraska

TOPSOIL CAN BE STOCKPILED IN CONSTRUCTION OF LEVEL BENCHES

O. W. Howe, Mitchell.--Thirty-two acres of land were bench leveled on the Scotts Bluff Experiment Station in the spring of 1956. Slope of the land ranged from 1/2 to 6 percent. It was believed that construction of benches on the steeper slopes without regard to replacement of topsoil would seriously impair soil productivity and create a highly variable soil profile condition with respect to intake rate and uniform distribution of water. Minimal procedures and type of equipment needed to stockpile topsoil for subsequent replacement on the leveled benches were tested and evaluated as a part of this investigation.

Earth was moved across the bench most economically with a combination of an elevating grader and a highway patrol. A 16-yard wheel scraper and crawler type tractor were used for longitudinal leveling.

Under the method used, removal of the topsoil was begun with the elevating grader at the one-third points in the bench section. Cutting progressed outward to the stakelines and all of the topsoil from the outer two-thirds of the bench area was stockpiled upon the middle one-third. The case of the elevating grader, that is, the distance between the plow and the point of delivery of the soil, should be one-third of the overall width of the bench. After the topsoil was stockpiled, subsoil from the upper one-third of each bench was transferred to the lower one-third of the next higher bench to level the benches and construct the escarpments and berms. This transfer was often done most economically with the scraper because of the longitudinal displacements made necessary by irregular contours, although the elevating grader and the blade were used to good advantage on the more uniform slopes. This method did not result in a perfect job of undercutting as the upper edge of the middle one-third of the section is left with thin topsoil.

Following the above procedure, bench leveling on fairly rough land with slopes averaging about 3 percent cost approximately $150.00 per acre. Where topsoil was not stockpiled on flatter slopes, the cost of leveling was about $100.00 per acre.

Colorado

TWO-CUTTING PRACTICE RECOMMENDED FOR MOUNTAIN MEADOWS

Forrest M. Willhite, Hayden K. Rouse, Eugene G. Siemer, and Albert R. Grable, Grand Junction.--The following display advertisement appeared in the Gunnison News Champion of June 27 and the Gunnison Courier of July 1, 1956:

"NEW CROP OF BALED HAY FOR SALE:

> This early cut hay is premium quality hay averaging 15 percent crude protein. Price $28 per ton f.o.b. ranch. Phone 038-R3 before July 4 if you want some.
>
> JOHN CRANOR"

Of the three basic recommendations for the improvement in yield and quality of mountain meadow hay--careful water control, adequate fertility and a two-cutting harvest--there has been the least acceptance of the early cutting idea. Mr. Cranor stated that

he had experimented with the two-cutting harvest on about 30 acres in 1955 with satisfactory yields and average analyses of hay on dry-matter basis as follows:

	Percent
Ash	7.95
Crude protein	15.21
Calcium	1.19
Phosphorus	0.256

(Analyses by Department of Animal Husbandry, Colorado A & M College.)

The yields for 1955 are not available but for hay cut on June 26, 1956, yields of 2.5 tons per acre (15 percent moisture) were obtained.

There appears to be an increasing recognition that the improved quality of early cut hay justifies the additional labor and the changes in management practices which are required.

North Dakota

LEACHING REDUCES SALT IN RED RIVER VALLEY SOIL

Carl W. Carlson, David L. Grunes, and Glen H. Cannell, Mandan.--Approximately 100,000 acres of the Red River Valley are severely affected by salt problems. A large part of the problem area is confined to topography of low intersecting ridges. Preliminary work showed that the ridges had excessive amounts of salt while the nearby depressions were non-saline. Observation wells located in the area showed the water table to be within 6 feet of the soil surface.

A series of small leaching basins was constructed on a ridge area in the fall of 1955. Non-saline water was applied as separate treatments (9 and 18 inches) to certain plots. The conductivity values of saturation extract were made on soil samples taken before and after leaching and are summarized in the following table:

Conductivity of saturation extract for soil samples from a ridge in Grand Forks County

Sample depth	Conductivity* before leaching	Conductivity* After Leaching	
		9 inches water	18 inches water
Inches			
0-6...............	9.1	5.8	4.2
6-16..............	13.8	8.6	4.9
16-28.............	24.6	12.5	7.7

*EC x 10^3 at 25° C.

Considerable salts were removed by the leaching treatments. Additional soil samples will be taken in the spring and fall of 1956 to determine whether the change is permanent.

Texas

GRASS ESTABLISHMENT DIFFICULT ON THE HIGH PLAINS

W. C. Moldenhauer, Big Spring.--An evaluation of 11 grass species or varieties and Nomad alfalfa for tolerance to low temperatures, drought and grazing was initiated in August 1954 near Midland, Tex. Becuase of adverse rainfall conditions, there has

been no chance to study anything except differential survival under the existing climatic conditions without grazing.

The seeded area was an old cultivated field with most of the north side eroded largely by wind to the sandy clay subsoil. Sand from the north side has accumulated on the south side of the field. Half of the replications were seeded in August 1954 after a sorghum cover crop was killed with 30-inch sweeps. The other half was seeded in April 1955. The plot area received very little moisture during 1955, and the present evaluation was made after approximately 2 inches of rain in the spring of 1956.

Stands on each plot were given a numerical rating as follows and these were averaged to get the index values presented in the table:

0 - Complete failure, no plants.
1 - Very few isolated plants.
2 - Numerous isolated plants.
3 - Small areas where the stand is good.
4 - Large areas where the stand is good.
5 - Good stand throughout.

Stand survival of 11 grasses and Nomad alfalfa under very adverse conditions in Midland County, Tex., 1955

Seeding	Fall seeding		Spring seeding		Overall average
	North side (eroded)	South side (accumulation)	North side (eroded)	South side (accumulation)	
	*Index**	*Index**	*Index**	*Index**	*Index**
Weeping lovegrass	0.50	1.75	0.50	1.75	1.1
Lehman lovegrass	0.75	1.75	3.00	4.00	2.4
Boer lovegrass	1.75	1.25	2.50	3.25	2.2
Wilman lovegrass	1.50	1.50	1.00	3.00	1.8
Sand lovegrass	1.75	0.75	1.00	1.00	1.1
Blackwell switchgrass	0	0	0.25	0	0.1
Common switchgrass	0	0	0	0.25	0.1
Blue grama	2.00	1.50	4.00	2.25	2.4
Sideoats grama	2.25	2.50	3.75	2.00	2.6
King Ranch bluestem	0.50	0.25	1.25	0.50	0.6
Blue buffelgrass	0	0	0.25	0.50	0.2
Nomad alfalfa	0	0	0	0	0
Average	0.9	0.9	1.5	1.5	1.2

* See text.

The overall stand on the spring-seeded grasses is somewhat better than that on the fall-seeded at this time. Also, overall stand ratings are identical on the eroded and sandy parts of the field. There are, however, species differences on the two parts of the field.

The outstanding grasses of this trial are the blue and sideoats grama, and the Lehman, Boer, and Wilman lovegrass. The gramas seem to be better adapted to the finer-textured soil, whereas the lovegrasses appear somewhat better adapted to the coarser textured soils. There was some survival of weeping and sand lovegrass and

King Ranch bluestem, but this was poor compared to the other lovegrasses and the two gramas. Only a few isolated plants of the switchgrasses and blue buffelgrass survived. No alfalfa was found.

In grass performance studies initiated this year, in cooperation with the Texas Experiment Station, it was found that Plains bristlegrass (Setaria macrostachya) and green sprangletop (Leptochloa dubia) showed much more seedling vigor than any of the selections of Bouteloua curtipendula, Be. gracilis, and Andropogon barbinodis studied, Green sprangletop was grown under irrigation only; Plains bristlegrass was grown under both dryland and irrigated conditions and responded similarly on both.

Washington

LODGING OF IRRIGATED CORN DIFFICULT TO MINIMIZE WITHOUT YIELD REDUCTION

C. E. Nelson, Prosser. --Experimental work in 1955 showed that hilling versus no hilling and deep cultivation versus shallow cultivation had no differential effect on lodging of Wis. 641AA field corn.

High nitrogen fertilization increased lodging. Mechanical breakage studies of the stalks after maturity, with the stalks containing 84 percent moisture, showed, however, that the stalks from plots receiving 100 to 400 pounds of nitrogen per acre were more resistant to breakage than those from plots receiving no nitrogen fertilizer. The greater late fall lodging of the nitrogen fertilized corn was due mainly to the greater ear height and larger ear weight as the stalks decreased in moisture content. These data are summarized in the following table:

Effects of nitrogen fertilizer on yield and lodging of field corn, Prosser, Wash., 1955

Nitrogen per acre	Breaking force*		Ear height	Ear weight	Ears per plant	Acre yield	Lodging
	Standing stalk	Third internode					
Pounds	*Pounds*	*Pounds*	*Inches*	*Pounds*		*Bushels*	*Percent*
0	5.85	109	40.5	0.61	1.10	108.2	22.8
100	6.16	113	42.5	0.73	1.12	132.5	29.6
200	6.20	112	42.2	0.73	1.13	133.2	31.9
400	6.20	111	42.4	0.73	1.13	134.1	31.9

* 84 percent moisture in stalk.

Since the 100-, 200-, and 400-pound nitrogen treatments gave similar response in yields and other measurements they are referred to collectively as the high nitrogen level treatments, in comparison with the check treatment.

Figure 1 shows the effect of plant populations at two nitrogen levels on yields. Maximum yield for either nitrogen level was at about 20,000 plants per acre. For the high nitrogen level the yield remained essentially the same from 20,000 to 26,000 plants per acre, whereas for the check treatment the yields decreased with higher population. The effects of plant population on lodging for the two nitrogen levels are shown in Figure 2.

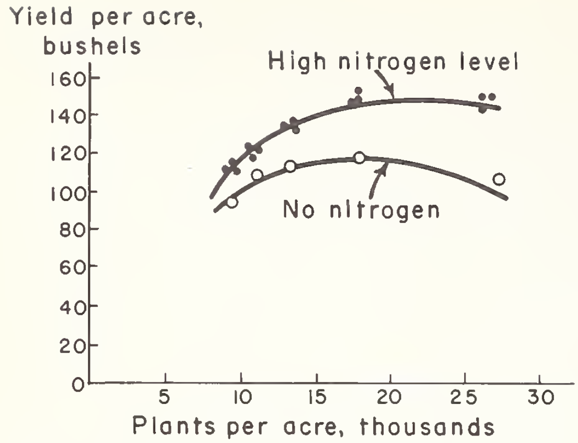


Figure 1.--Effect of population at two nitrogen levels on corn yield, Prosser, Wash., 1955

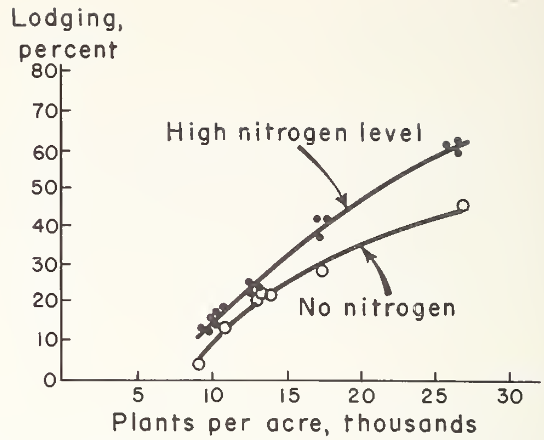


Figure 2.--Effect of population at two nitrogen levels on lodging of corn, Prosser Wash., 1955

Conclusions from this year's work are:

Lodging increased progressively from 9,000 to 26,000 plants per acre.

Lodging was greater with the high nitrogen level and was accentuated with increasing plant population, in comparison with the check treatment.

Maximum yields were obtained at 18,000 to 20,000 plants per acre.

Lodging may be reduced by using fewer plants per acre, or by having a low nitrogen level. Either practice would result in a reduction in grain yields.

In order to take advantage of the greater yield from the high nitrogen level and still minimize lodging, the corn should be harvested as early as possible after it has reached maturity. Corn is considered mature when the moisture in the grain has dropped to 33 to 34 percent.

Oregon

AGAIN IN 1955, PROTEIN CONTENT DIFFERS IN FIELD CORN HYBRIDS

Carl A. Larson, Hermiston.--Fifteen field corn hybrids were grown under a uniform application of 150 pounds of nitrogen per acre. The soil was loamy sand of the Ephrata series. The corn grain and the stover were analyzed for nitrogen and these values converted to percent protein. Average protein content in grain from different hybrids ranged from 6.69 to 9.82 percent. Protein in the stover ranged from 2.57 to 4.19 percent.

The yield of grain from the hybrids ranged from 127 to 159 bushesl per acre with 15 percent moisture. The yield of stover ranged from 2.16 to 3.57 tons per acre dry weight.

HYDROLOGY-GENERAL

Texas

TIME OF CONCENTRATION ESTIMATED BY NEW FORMULAE

R. W. Baird and Monroe A. Hartman, Waco.--This item appeared on page 62 of Quarterly Report No. 7, February 1956. The two formulae on that page should be corrected to read:

$$T_c = 5 + 75 \sqrt{4} \quad \dots\dots\dots\dots\dots\dots\dots \quad (1)$$

where T_c = Time of concentration in minutes

A = Size of drainage area in square miles

The error of estimate for all of the watersheds with this formula was 22 percent.

$$T_c = 9.25 + \frac{9.05L}{\sqrt{S}} - \frac{1.55A}{N} \quad \dots\dots\dots\dots\dots \quad (2)$$

where T_c = Time of concentration in minutes

L = Length of water course in miles

S = Land slope in percent

A = Size of drainage area in square miles

N = Surface retardance factor computed by weighting and shown in the table.

The error of estimate for this formula was 12.8 percent.

<u>Ohio</u>

PERCOLATION AFFECTED BY SOIL AND RAINFALL

F. R. Dreibelbis and L. L. Harrold, Coshocton. --Data on the monthly percolation from the Coshocton monolith lysimeters provide useful information in the study of water replenishment to springs, wells, and streams. Such information is also useful in estimating losses of plant nutrients through leaching.

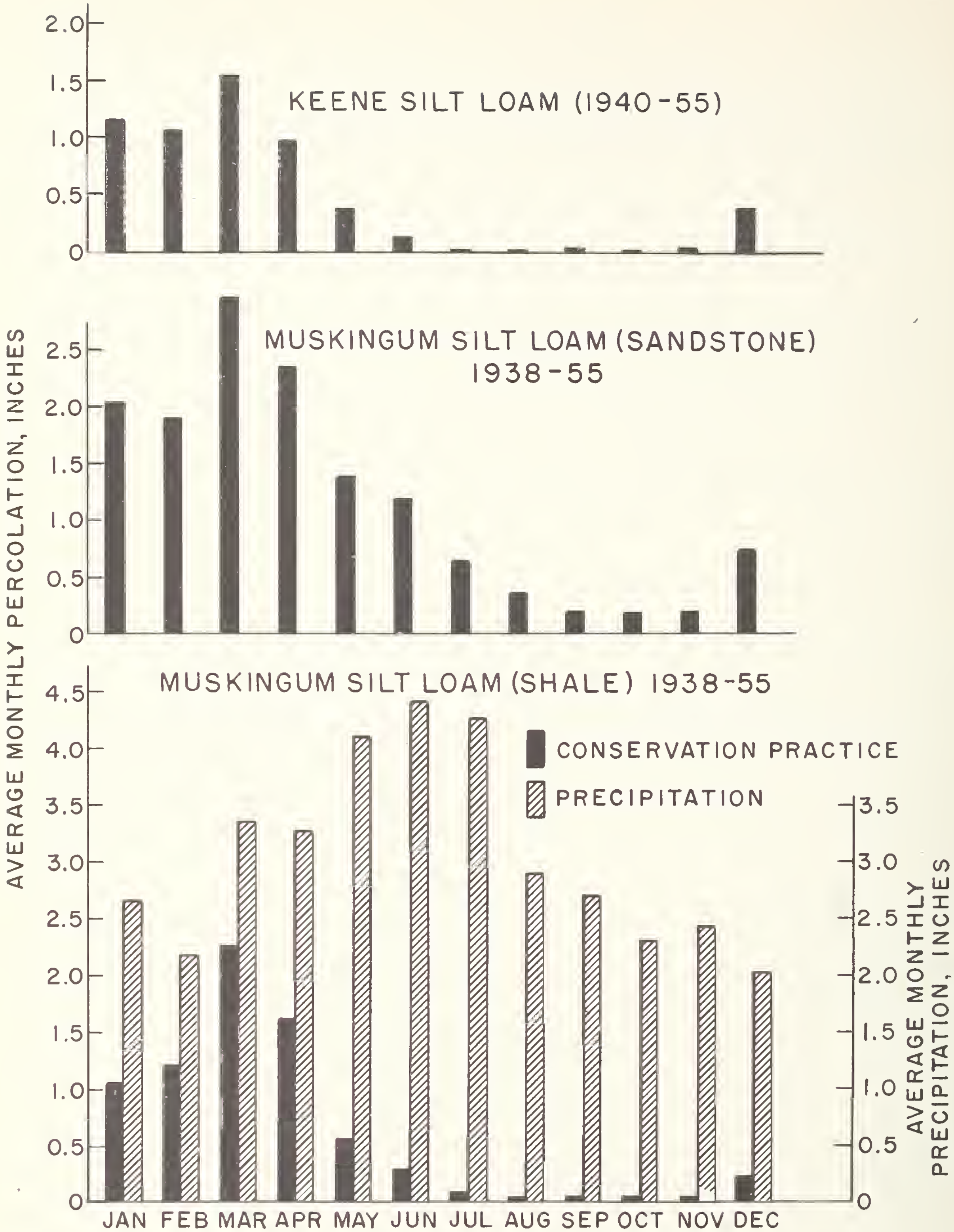
Average monthly percolation values are shown in the accompanying figure for Muskingum silt loam and Keene silt loam. Greatest percolation has occurred in March, followed by April, January, February, May, and December. During the other 6 months only small amounts of water percolated through the soil. The year 1954, as well as the preceding year, had a rainfall deficiency of almost 10 inches for each year. As a result, there was no percolation in any month in 1954 from one of the lysimeters.

During the 18-year period there were some years with no percolation in January, February, September, October, November, or December.

The amounts and distribution of rainfall influence percolation considerably, particularly during the first half of the year. Most of the percolation occurs during the first 4 months of the year, the total cumulative percolation for this period amounting to 82 percent of the annual total on the Muskingum silt loam (shale) and 80.6 percent on the Keane silt loam. For the period January to May, the values are 89.5 percent and 87.3 percent on the same areas, respectively.

Average monthly rainfall values in the graph compare percolation values with rainfall for the same periods. Average monthly rainfall was over 2 inches for the period, 1938-1955. The months of May, June, and July averaged over 4 inches each. The average annual rainfall was 36.51 inches. Average annual percolation values for the same period amounted to 14.35 inches on the Muskingum silt loam (sandstone); 7.50 inches on the Muskingum silt loam (shale); and 6.01 inches on the Keene silt loam. All lysimeters used in this comparison were in conservation practice.

During the growing season (May to September) evapo-transpiration ordinarily depletes the soil-moisture supply so much that little percolation occurs during this period.



Average monthly percolation from lysimeters and average monthly precipitation, Coshocton, Ohio, 1938-1955.

During the fall months evapo-transpiration rapidly diminishes and soil-moisture accretion begins to exceed depletion so that a gradual building up of the soil moisture supply occurs during the late fall and winter months.

As soon as the soil moisture content in the profile exceeds the field capacity, percolation begins. This often occurs during December or January. The peak of soil-moisture content occurs in March or April, depending upon the weather pattern for the year. It is generally during March or April that amounts and rates of percolation reach their peaks for the year.

Ohio

MULCH AND PLOW-PLANT REDUCE RUNOFF, EROSION FROM WATERSHEDS

F. R. Dreibelbis and L. L. Harrold, Coshocton. --Precipitation for each month of the April-June 1956 quarter exceeded normal--the excess amounting to 5.20 inches. Wet weather delayed tillage operations and hay making for about 1 month. Rainfall of 7.08 inches in May and 5.07 inches in June was of frequent high intensity causing runoff on all watersheds in corn.

Runoff and erosion from watersheds in corn, Coshocton, Ohio, 1956

Watershed No.	Area	Treatment	Runoff		Erosion per acre	
			May	June	May	June
	Acres		*Inches*	*Inches*	*Tons*	*Tons*
106...........	1.56	Check	0.15	0.79	0.168	1.22
121...........	1.42	Contour	.17	.44	.019	.553
188...........	2.05	Contour, mulch	.06	.04	.010	.015
191...........	1.20	Contour, plow-plant	.003	.011	0	Trace

The greatest amount of runoff occurred on the straight-row plowed watershed No. 106--0.94 inch for the May-June period. Next highest was 0.61 inch from the contour-plowed watershed. Next was 0.10 inch from the mulch watershed and least, 0.014 inch from the plow-plant watershed.

Maximum rate of runoff came from watershed No. 106, 1.54 inches per hour; from No. 121, 0.50 inch per hour; and from the others, less than 0.1 inch per hour. Maximum 3-minute rainfall intensity was 3.50 inches per hour and the maximum 7-minute rate, 3.17 inches per hour. Peak runoff resulted from the former.

Erosion was in the same order as the runoff--greatest on the check watershed and least on the plow-plant. Mulch tillage was also effective in reducing soil loss.

The stand of corn on the plow-plant area is good--even better than on many of the normally tilled areas. Although weeds in the former were less than in the latter, it was necessary to spray for control. There was plenty of moisture, a factor in weed growth on the plow-plant area.

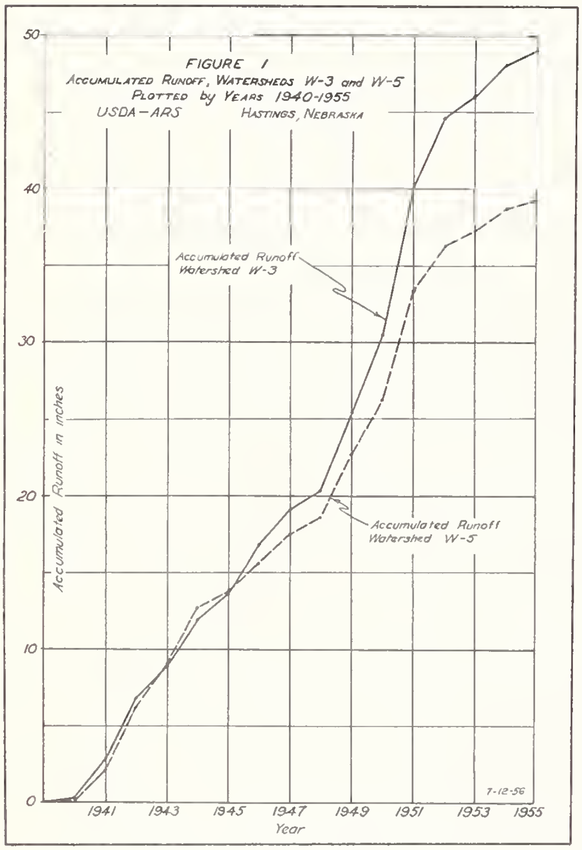
Wet soil delayed plowing operations by nearly a month. Grass was extremely high and the soil too wet in spots when plowed. Planting operations followed plowing by only a few hours. By omitting tillage, the structure of the wet soil was not destroyed.

Nebraska

CONSERVATION MEASURES REDUCE RUNOFF IN GREAT PLAINS

John A. Allis, Hastings.--Runoff records have been obtained from a 411-acre conservation watershed (W-5) and a 481-acre non-conservation watershed (W-3). These watersheds are on loessial soils and represent a large area in the Central Great Plains.

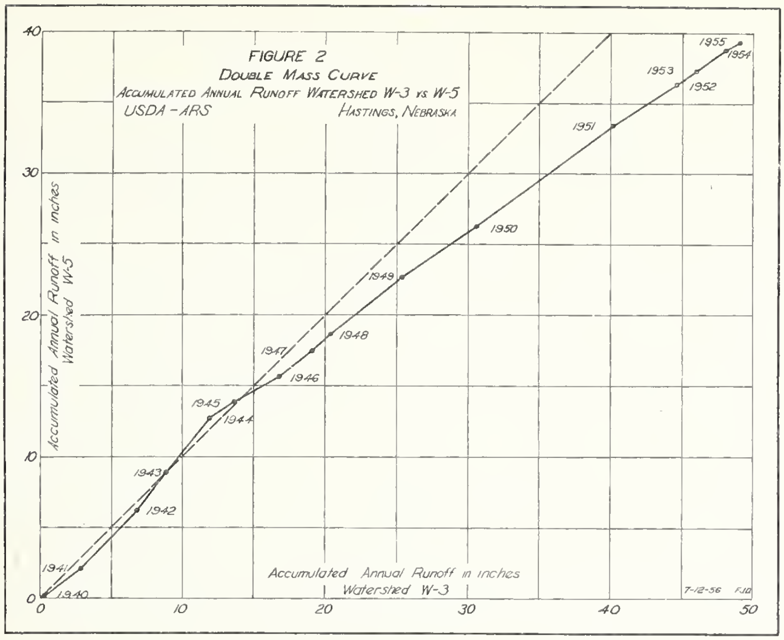
During the calibration period of 1940 to 1946, when both areas were straight-row farmed, the peak rates and total runoff were similar. The records, however, indicate a definite trend toward lower peaks and less runoff on watershed W-5 beginning in 1947, when a program of conservation measures was initiated.



Significant results have been obtained from these two watersheds. In the 16-year period rainfall averaged slightly above 22 inches. (The rain gages show a consistently higher rainfall on watershed W-5 than on W-3 for the entire period of record.) The accumulation of runoff plotted by years in Figure 1 shows that the runoff from the two areas was similar for the period of 1940 to 1946; however, beginning in 1947, differences in runoff developed. In the 9 years (1947-55), there were 8.58 inches less runoff on watershed W-5 than on watershed W-3, or a savings of almost 1 inch of water per year.

The effect of conservation measures on runoff is also indicated by plotting the double mass runoff curve for the two watersheds in Figure 2. From 1940 through 1946, with possible normal deviations in data, the runoff from watershed W-3 is practically equal to the runoff from watershed W-5. This is indicated on a 45-degree line where $Q_5 = Q_3$. Beginning in 1947 and at the time the application of conservation measures was started on watershed W-5, there is a decided break-away from the 45-degree line, and the slope of the new line, 1947 to 1952, is $Q_5 = 0.74\ Q_3$. For the 3-year period, 1953-55, the slope of this line is $Q_5 = 0.66\ Q_3$. In other words, there was a reduction of 26 percent in runoff for the 6-year period of 1947-52 and a 34 percent reduction in the 3-year period of 1953-55.

Five of the six farmers in watershed W-5 are cooperating in placing recommended conservation practices on their land. One owner with 43 acres of cultivated land in this watershed still farms in straight rows. Practically all the cultivated land in watershed W-3 is straight-row farmed.



The ultimate goal is to apply the best known conservation practices on all land in watershed W-5 and to continue the straight-row farming on watershed W-3. The runoff results to date, however, show a definite trend that conservation practices reduce peak rates and total runoff on a 411-acre watershed in the loessial soils of the Great Plains.

Michigan

SOIL LOSS LARGEST ON CULTIVATED WATERSHED

Nina C. Cottom, East Lansing.--Heavy rains were received during the first part of the April-June 1956 period. The total quarterly precipitation at the cultivated watersheds amounted to 13.05 inches, or 137 percent of normal, with April and May receiving the greatest amount. April precipitation amounted to 3.99 inches, or 155 percent of normal; May, 6.26 inches, or 183 percent of normal, and June, 2.80 inches, or 80 percent of normal. Total quarterly precipitation at the wooded watershed amounted to 13.13 inches, or 138 percent of normal. During the quarter there were 3 runoffs on watershed A, rye cover after corn, and 6 runoffs on the wooded watershed. There were no runoffs on watershed B in heavy alfalfa cover. Totals for the first half of the year are given in the following table.

Runoff and soil loss from cultivated and wooded watersheds, East Lansing, Michigan, January-June, 1956

Watershed	Crop	Drainage area	Total runoff	Soil loss per acre	Peak runoff per hour
		Acres	*Inches*	*Pounds*	*Inches*
A........	Rye after corn	1.98	6.15	237.3	3.41
B........	Alfalfa	1.35	6.02	48.6	0.63
W........	Woods	1.65	0.77	9.03	0.05

GEORGIA WATERSHEDS LOSE VERY LITTLE ANNUAL RAINFALL AS RUNOFF

James B. Burford, Blacksburg, Va.--Short term rainfall-runoff records for four watersheds located near Americus, Ga., indicate that a very small part of the annual precipitation was lost through runoff. The precipitation and runoff data for the watersheds having drainage areas of 17.9, 32, 42, and 59.2 acres are briefly summarized in the four accompanying tables:

TABLE 1.--Precipitation and runoff from 17.9-acre Watershed W-I, Americus, Ga., 1938-1943

Year	Land use	Total precipitation	Runoff	
		Inces	*Inches*	*Percent*
*1938......	Corn and velvetbeans 85%, cotton 15%.	12.69	0.91	7.17
1939......	Corn and velvetbeans 56%, cotton 44%.	45.20	1.06	2.34
1940......	Corn and velvetbeans 64%, cotton followed by fall-sown oats 36%.	45.79	1.54	3.36
1941......	Oats, velvetbeans followed by fall-sown oats 29%, peanuts 19%, corn 15%, cotton 37%.	38.53	.53	1.37
1942......	Corn and velvetbeans 18%, cotton 26%, wheat 29%, peanuts 27%.	52.47	1.95	3.72
**1943......	Not recorded.	32.78	.49	1.49
***Average...		45.50	1.27	2.79

* August through Decdmber.
** January through May.
*** Part yrs. not included.

TABLE 2.--Precipitation and runoff from 42-acre Watershed W-II, Americus, Ga., 1938-1942

Year	Land use	Total precipitation	Runoff	
		Inches	*Inches*	*Percent*
*1938.......	Winter peas followed by corn 20%, corn and peas 48%, peanuts 9%, oats 3%, idle 2%.	15.30	.62	4.05
1939......	Same as 1938.	46.36	.39	.84
1940......	Idle land medium cover 68%, peanuts 9%, peas 5%.	49.79	.13	.26
1941......	Oats followed with peas 25%, idle land (medium to heavy cover) 48%, winter peas 9%.	41.73	.10	.23
**1942......	Not recorded.	15.30	.03	.20
***Average...		45.96	.21	.46

* August through December.
** January through March.
*** Parts yrs. not included. 18% of area in loblolly pine, planted in 1938. All runoff passed through wooded area for a distance of 500 to 1000 ft.

TABLE 3.--Precipitation and runoff from 32.0-acre Watershed W-III, Americus, Ga., 1938-1942

Year	Land use	Total precipitation	Runoff	
		Inches	*Inches*	*Percent*
*1938.....	Cowpeas and volunteer crotalaria 86%	14.51	.48	3.31
1939.....	Idle 82%, cotton and vetch (good cover) 4%.	46.69	.15	.31
1940.....	Idle (good cover) 79%, corn and weeds 7%.	46.16	.03	.06
1941.....	Corn and weeds (late heavy cover) 39%, idle (heavy cover) 42%, cowpeas 5%.	40.87	.03	.07
**1942.....	Not recorded.	8.33	.0	.0
***Average..		44.57	.07	.16

* August through December.
** January through Rebruary.
*** Part years not included. 13% of area was planted to pine trees in 1938, waterway--1%.

TABLE 4,--Precipitation and runoff from 59.2-acre Watershed W-IV, Americus, Ga., 1938-1943

Year	Land Use	Total precipitation	Runoff	
		Inches	*Inches*	*Percent*
*1938.....	Idle 57%, corn 15%, cotton 11%, peanuts 10%	14.81	.79	5.33
1939.....	Wheat and hay (good cover) 29%, cotton 27%, peas 20%, corn 8%, peanuts 6%, pasture and idle 3%.	47.57	1.99	4.18
1940.....	Weeds and hay (good cover) 18%, cotton 57%, corn 9%, peanuts 6%, peas 3%.	49.46	1.08	2.18
1941.....	Idle (medium to heavy cover) 75%, weed-peas (light cover) 10%, corn 6%, cotton 2%.	42.75	1.77	4.14
1942.....	Small grain 84%, peanuts 6%, idle 3%.	46.32	1.43	3.09
**1943.....	Not recorded.	30.22	5.76	19.06
***Average..		46.52	1.57	3.37

* August through December.
** January through April.
*** Part years not included. Homelot and channel 2%, road 5%.

These watersheds are located in the sand and sandy loam areas of the Middle and Upper Coastal Plain. Norfolk and Ruston sandy loams,with an impeding stratum at 15 to 26 inches, make up 95 percent of the W-I area. The predominant soils for W-II are well-drained Ruston loamy sand and Norfolk sand. Well-drained Orangeburg and Ruston sandy loams predominate in W-III. Ninety-two percent of the W-IV area is Greenville loam and sandy loam, with a slightly impervious to impervious stratum at 14 to 16 inches.

The records show the small amount of runoff occurring, together with the extreme variations in average annual runoff to be expected from watersheds of this type. In this case these variations appear to correlate with soil structural differences. The two

watersheds with the higher average annual runoff values, W-I and W-IV, have soil profiles with impeding strata as compared to W-II and W-III, which have well-drained soils.

SEDIMENTATION

Mississippi

INSTALLATIONS MADE FOR STUDYING STREAM CHANNEL SEDIMENTATION

Russell Woodburn, State College.--Three new installations of log chain were made on Big Sand Creek, Carroll County, in the reach between the mouth of Magic Creek and the Carrollton bridge. These chains were anchored and placed longitudinally on the channel bottom and an elevation datum established from which to measure subsequent scour and deposition. At one location the installation included four chains 30 feet long, spaced at intervals across the flow section to permit observations of channel changes associated with different depths of stream flow.

A basis for degradation studies on Little Rock Creek channel, near Carrollton in Carroll County, was also established. Ranges were located at appropriate intervals and cross-sections surveyed along about 2.5 miles of the channel from station 5+00 to station 140+00. In this case it is desired to document channel grade change occurring by virtue of several large desilting basins in the upper watershed.

Mississippi

SEDIMENT ACCUMULATION REPORTED FOR FOUR RESERVOIRS

Russell Woodburn, State College.--Resurveys on four drop-inlet desilting basins in Marshall County provide additional information on rates of sediment yield in the area. Two of these basins were surveyed by ARS and two by SCS. The calculations for each were made by ARS. The sediment accumulation and other pertinent data are shown in the following table.

Recent sediment surveys on drop inlet detention reservoirs, Mississippi, 1951-1956

Name	Location	Drainage area	Active gully area	Original capacity to top of drop inlet	Sediment accumulation	Age	Field surveys made by
		Acres	*Acres*	*Acre feet*	*Acre feet*	*Years*	
Andrew Smith*	Marshall County (Galena)	209	16.4	22.7	3.89△ 0.75□	2.5	ARS
W. W. Murphy*	Marshall County (Galena)	133	23.7	22.68	2.96△ 1.23□	2.5	ARS
Y. B. DeLapp**	Caroll County (Little Rock Creek)	163	15		7.84	4	SCS
Walter Henry**	Carroll County (Magic Creek)	50	7		4.58	4	SCS

*Nov. 1953 to May 1956 active period of sediment accumulation.
**Oct. 1951 to Oct. 1955 active period sediment accumulation.
△ Sediment volume below top of riser pipe. □ Sediment volume above top of riser pipe.

A paper entitled, "Sediment Problem Studied in the Yazoo River Watershed," by Russell Woodburn and John Kozachyn was published in the May issue of Mississippi Farm Research, official organ of the Mississippi Agricultural Experiment Station.

HYDRAULICS

Oklahoma

HYDRAULIC CHARACTERISTICS OF CHANNELS UNDER STUDY

W. O. Ree, Stillwater.--Two large channels, both planted to wheat, were tested to evaluate the Manning coefficient at various flow depths ranging from 0.5 foot to 3.0 feet. The drill rows in one channel ran lengthwise of the channel and in the other they ran crosswise. In other respects the channels were approximately alike. At the time of testing, the wheat was green and had just headed out. The data have not yet been analyzed.

The Bermuda-grass--Reed canarygrass channel is being subjected to wet and dry cycles of 5 days of continuous flow followed by 15 days of no flow. This will be continued through three such cycles before subjecting the channel to flow tests of high velocity. The object of the testing is to learn whether prolonged periods of wetting are harmful to the grass and reduces its effectiveness against scouring. Visual evidence so far indicates that the treatment is beneficial for the grass.

Minnesota

HEAD LOSSES IN TILE DRAINS BEING ESTABLISHED

Fred W. Blaisdell, St. Anthony Falls, Minneapolis.--Quarterly Report No. 5, August 1955, carried an item which showed there is little benefit, in terms of head loss savings, in joining tile drain laterals to mains at a 45-degree angle when the laterals and the main are the same size.

Experimental work has continued throughout the year, and tests on junction angles varying from 15° to 165° have been made over the full range of possible discharges for a lateral half the area of the main. The energy loss curves exhibit much the same shape as those previously determined when the lateral and the main were of equal size. However, the loss coefficients are much higher for the smaller lateral if the proportion of the flow entering from the lateral is the same for both lateral sizes. The velocity in the smaller lateral is larger of course, thus greater turbulence and a higher loss should be expected. It is anticipated that further analysis of the data will be deferred until data on other lateral sizes is available.

Minnesota

ENTRANCE LOSSES AND ANTI-VORTEX DEVICES FOR HOOD-INLET STUDIED

Fred W. Blaisdell, St. Anthony Falls, Minneapolis.--Tests during the quarter concerned: 1) the effect of pipe wall thickness on the performance and the entrance loss of the hood inlet, 2) performance of a well-rounded hood inlet entrance having low entrance loss, 3) an evaluation of the sliced inlet developed in Missouri, and 4) a trial of a flat anti-vortex plate as a substitute for the splitter anti-vortex wall.

The performance of entrances having various wall thicknesses was uniformly satisfactory. The flow contraction for very thin-walled entrances was much more noticeable than for the thicker walls, but the entrances sealed at low heads and performed satisfactorily.

The entrance loss coefficient was found to be constant and to average 0.83 for square-edged entrances having wall thicknesses greater than 0.05-pipe diameters. The

hood length was 3/4-pipe diameter for all tests. The entrance loss coefficient increased rapidly when the wall thicknesses were reduced below 0.05-pipe diameters. The thinnest wall that it was possible to machine and test had a thickness of 0.01-pipe diameters. The entrance loss coefficient was 1.02.

The entrance loss coefficient for the well-rounded hood inlet averaged 0.16. This entrance was formed by adding a radius of 0.207-pipe diameters to the 3/4-pipe diameter hood entrance. The entrance wall thickness was 0.207-pipe diameters and the actual hood at the upstream end was 0.53-pipe diameters. The performance of this inlet was equally as satisfactory as the square-edged hood inlets and superior to the well-rounded inlet without a hood, since the well-rounded hood inlets sealed off at lower heads. The lower entrance loss, although greater than the 0.10 loss obtained for the well-rounded inlet without a hood, will be an advantage in those cases where the priming characteristics of the hood inlet and the low entrance loss of the well-rounded inlet are both important. For the conditions of the laboratory tests, the well-rounded inlet carried about 14 per cent more water than a comparable thin-walled, square-edged hood inlet.

A sliced inlet, as developed at the University of Missouri, was tested. This inlet had a slope of 2.1, a length of 1.2-pipe diameters and an inlet plate as described in the Missouri report. These dimensions were selected as respresenting the inlet that seemed to have the best performance as determined by the Missouri tests. The sealing of the inlet was similar to that for a hood inlet with the inlet plate having no apparent favorable or unfavorable effect on the sealing. Once sealed, the inlet plate prevented entrance of air into the spillway until the pool level dropped to the bottom of the inlet plate. This fluctuation of the headpool over a considerable range of levels seems undesirable. As regards vortex tendencies, some sort of anti-vortex device is needed to prevent the formation of strong vortices and the entrance of considerable amounts of air into the pipe. The entrance loss coefficient was 1.29, about one-third greater than for a comparable hood inlet. No further tests were run on the sliced inlet since it had no apparent advantage over the hood inlet.

There have been a number of objections voiced to the splitter anti-vortex wall suggested for use in connection with the hood inlet. Mr. Paul Jacobson, Iowa State Conservation Engineer, tried out a flat anti-vortex device on a small demonstration model and suggested that tests be conducted. Exploratory tests indicated that a flat plate welded to the outside crown of the pipe would adequately prevent vortex formation. A circular plate with a diameter of 1.5-pipe diameters centered on the tip of the hood was the minimum size that performed satisfactorily. It is not known whether this plate size should vary with the discharge capacity of the pipe or with some other parameter. For the one test conducted, the performance of the plate having a diameter 1.5 times the diameter of the pipe seemed somewhat superior to that of the splitter anti-vortex wall. The entrance loss coefficient was identical with that obtained for the same inlet with a splitter anti-vortex wall.

The present series of tests on the hood inlet is now complete. The test apparatus will not be usable for the next few months due to laboratory revisions. However, this will not retard work on the hood inlet, since the preparation of a technical report on the tests had been planned for this period.

LIST OF RECENTLY PUBLISHED PAPERS AND PUBLICATIONS

Some of the recently published papers and publications written solely or jointly by staff members of the Soil and Water Conservation Research Branch are listed below.

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